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Mr. G. D. DELPRAT, C.B.E., General Manager Broken Hill Pty. Ltd., and Member of Executive Committee of the Institute of Science and Industry.

SCIENCE AND INDUSTRY.

VOL. 2.] JANUARY, 1920. [No. 1.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

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Co-operation with the States.

ADVERSE criticism of the proposals to establish the Institute has been made on more than one occasion on the ground that no steps have been taken to secure the co-operation of the State Governments and Departments in the work. A brief review of the facts will show that these criticisms are wholly lacking in foundation. Not only were representatives of the State Governments present at the original conference when the scheme for the Institute was first launched, but a great part of the work of the Institute is already being carried out in co-operation with one or other of the States. Other schemes for co-operative work of a more permanent nature are only awaiting the passing of the Bill to establish the permanent Institute. The State Universities, Technical Schools, and other State or semi-State institutions throughout Australia are actively co-operating in the work, and it is, in fact, only by reason of such co-operation, which has been given fully, freely, and gratuitously, that the Institute has so far been able to carry on its work in the absence of laboratories of its own.

SCIENCE AND INDUSTRY.

When the Institute of Science and Industry Bill was under debate in the House of Representatives, Mr. L. E. Groom, Minister for Works and Railways, pointed out that it was the policy of the Commonwealth Government, and of those who had been in charge of the work of the Institute all through, to act in complete harmony and co-operation with the State authorities. This desire for co-operation may be seen from the very beginning of the movement to establish the Institute. At the initial Conference, which the Prime Minister convened in January, 1916, for the purpose of considering what steps should be taken for wedding science to industry, all the State Governments were invited to send representatives, with the object of securing their co-operation and assistance from the outset. Not only were there present at that Conference representatives of science and industry from all States, but the State Ministers of Agriculture of Victoria, South Australia, and Queensland also attended and took part in the deliberations. The Ministers of Agriculture for the other States were invited, but were unable to attend. It was at this Conference that the scheme upon which the Institute of Science and Industry Bill is based was formulated and adopted.

In accordance with the provisions of this scheme, a temporary Advisory Council was appointed, and held its first meeting in April, 1916. In addition to representatives of each of the State Universities and of various industrial interests, the State Ministers of Agriculture of Victoria, South Australia, and Queensland, and the Director of Agriculture, New South Wales, representing his Minister, were present. Moreover, it was decided at that meeting that, in order that each State should not have less than three representatives on the Council (in addition to the Ministers of Agriculture, who are *ex officio* members), the Commonwealth Government should ask certain of the State Governments to nominate additional representatives. This was done, and representative State Committees were thus brought into existence in each State. An Executive Committee was appointed, and, in conjunction with the State Committees, proceeded to carry out the work for which the temporary Advisory Council was appointed. In carrying out this work, special attention was given to the question of co-operating with the State Government scientific and technical Departments and other institutions carrying on scientific work. Members of the Executive Committee made special visits to New South Wales and Queensland for the express purpose of obtaining the sympathy and co-operation of State Ministers and others in the work of the Institute.

In both these States members of the Government expressed their willingness to co-operate, but when the question of the work and policy of the Institute was brought up for discussion at the Premiers'

Conference in May, 1918, Mr. Holman, the New South Wales Premier, was critical, and brought before the Conference a motion to the following effect:—

That the Commonwealth Government be requested to cease the procedure at present being carried out whereby unnecessary expenditure is being incurred in the assumption of functions by the Commonwealth Bureau of Science and Industry, which are at present being efficiently performed by the States.

Mr. Watt, the Acting Prime Minister, then presented to the Conference a report showing the policy and scheme of organization of the proposed permanent Institute. He fully explained the position, and, generally speaking, the Premiers of the other States cordially supported the Commonwealth proposals. For example, the Premier of South Australia, Mr. Peake, said as follows:—

"In my view, this is one of the big questions which we might very well feel satisfied belong rather to the Commonwealth than to the States, because no scientific discovery will be purely a State affair. It is simply a question of whether the Commonwealth can show us that we are going to have increased efficiency without duplication of the cost of the State Departments. If it can show us, then I, for one, will heartily support the Commonwealth taking over the whole of the departments of scientific research, because I think they would do the work much better. . . ."

"I would like to put another view from the stand-point of the States. I do not think any State stands more strongly for State rights than does South Australia, but we regard science as on an entirely different footing from practical administrative work. Science has no boundaries, and the operations of a scientific bureau could very well be spread over the whole of Australia, both from the point of view of more effective work and from the stand-point of economy. What is the use of five or six different State Departments pursuing inquiries on different lines when possibly one body could much more effectively perform the work of investigation and research? . . . ."

"I think that there must necessarily be greater strength in the scientific methods of the Commonwealth than in those of the States. The greater scientific knowledge which money will enable the Commonwealth to obtain will strengthen every department, and I think that in this case the Commonwealth can very well take over all scientific investigation on behalf of the general community."

Mr. Lee, the Premier of Tasmania, then spoke, and he, too, was sympathetic to the Institute. He said—

"I think no very great harm can come of this departure, provided the Commonwealth Bureau exercises a reasonable amount of discretion, that is to say, that any matters which are being investigated by a State Bureau should not be undertaken by the Commonwealth, matters peculiar to the State in which the Bureau exists. If those are left to the States, I can quite imagine there are many questions that can be well investigated by the Commonwealth. In matters that are common to all States, it appears to me the Commonwealth Bureau can effect very essential service to the whole Commonwealth."

Mr. Lefroy, the Premier of Western Australia, also supported the proposal to establish the Institute. He expressed the following views:—

"No doubt, the question of scientific research is more important at the present moment than, perhaps, at any previous time in Australia. There are many diseases in stock that are common to the whole of Australia, and I am of

opinion that better research work could be done by one central body. There are not many men in the world who are experts in these matters. They are very difficult to obtain. If one State were able to get the services of the most experienced man to go into research work, the other States would be unable to avail themselves of his services. Although I am very jealous of the sovereign rights of the States, at the same time I think this research work could be better done through one central body. I should be prepared to fall in with any arrangement that might have that object in view, seeing that it is in the interests of my own State that it should be done. There are many difficult problems which we shall have to deal with in Australia in the future, and they could be better dealt with by one central body."

The Premier of Victoria, Mr. Lawson, was strongly in favour of co-operation between the Commonwealth and the States in scientific research. He said as follows:—

"I confess to a large measure of sympathy with the President's views as an expression of an abstract principle. It is, perhaps, possible that the Commonwealth, in the exercise of this right, might logically take over certain other matters which are specifically State functions, but I do not fear that. I think we might reasonably welcome this institution as capable of doing something which, unfortunately, the States have not succeeded in doing. In the State activities and State inquiries there have been overlapping and duplication; but, by means of centralization, more satisfactory results can be achieved. Mr. Swinburne's memorandum, which the Acting Prime Minister read, states the case fully. We want concentration and co-ordination, and we ought to leave it to one body to make specific inquiries, instead of all the States independently investigating the same subject, thus making for duplication. . . . I say let us welcome the Commonwealth, and work hand in hand with it in this matter."

This shows quite clearly, not only that all reasonable steps were taken by the Commonwealth Government and by those in charge of the work of the temporary Advisory Council to obtain the sympathy and co-operation of the State Governments in the work of the proposed Institute, but also that the States, on the whole, cordially welcome the Commonwealth proposals. A brief survey of the activities of the Institute will now show how these proposals for co-operation have been carried into effect, and we shall see that a large part of the work of the Institute is now being carried out in co-operation with one or more of the States.

First of all there is the prickly pear scheme, which involves the expenditure of a sum of £8,000 per annum for five years. Both the New South Wales and Queensland State Governments have agreed to co-operate with the Commonwealth in the scheme, and each of these States will contribute a sum of £2,000 a year towards the cost of the work, the business side of which will be controlled by a small Committee representing the Commonwealth and the two contributing States. Though the feeling of the Premier of New South Wales was, in 1918, somewhat opposed to co-operation with the Institute, much has since been done to secure co-operative research in that State. Not only has

the New South Wales Government agreed to co-operate in the prickly pear scheme, but it has also undertaken to provide £1,000 annually for a period of five years, to be used in co-operative work with the Institute in investigating the white ant, blow-fly, and other pests. In addition, the State Government has approved of a scheme by which the New South Wales Forest Commissioners will co-operate with the Institute in carrying out research work on forest products. The New South Wales Department of Education is co-operating with the Institute in connexion with tanning investigations, which are being carried out at the Tanning School, Redfern; and also in connexion with yeasts and breadmaking, in regard to which experimental work is being carried out at the School of Bakery attached to the Sydney Technical College. Investigational work is also being carried out in co-operation with the New South Wales Department of Public Health and the Sydney University; whilst the State Director of Agriculture and a number of leading State officers are members either of the State Committee or of various Special Committees established by the Institute.

In Victoria, both the Director and the Superintendent of the Department of Agriculture are members of the Executive Committee of the Institute, and the Department which they control is co-operating in the work, more particularly in connexion with viticultural researches, which are being carried out at Mildura. In this State, the University of Melbourne has been of the greatest assistance in the work of the Institute. The Ballarat School of Mines and Industries is co-operating in pottery investigations, and other State and semi-State institutions have freely assisted and co-operated with the Institute.

In Queensland, the Institute is co-operating with the Department of Agriculture and Stock in investigations on the blow-fly and in inquiries on cotton cultivation. It is carrying on co-operative work with the Queensland Acclimatisation Society in the cultivation of castor beans. The State University has rendered valuable assistance in experiments on mangrove bark as a tanning agent, on the construction of a mechanical cotton-picking machine, and on other problems. The Government has made available the services of one of its officers as Chairman of the Queensland State Committee of the Advisory Council.

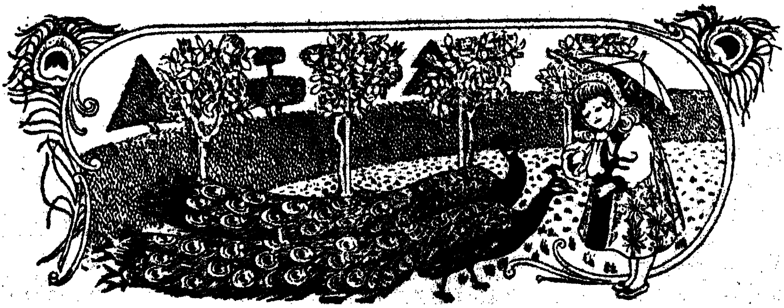
In Western Australia, a large amount of investigational work on a co-operative basis is in hand, mostly under the joint control of the State Government and the Institute. each bearing half the cost. The Western Australian Government has offered the Institute a sum of £5,000 towards the capital cost for the erection of a forest products laboratory, as well as 25 acres of valuable land as a site for the laboratory. The clays of that State are being tested in co-operation with the Institute at the Geological Survey Laboratory, and several

officers of scientific and technical State Departments are cordially assisting in the work of the Institute. At the request of the Western Australian Government, an investigator has been sent abroad to inquire into modern methods of running a forest products laboratory. Half the expenses are being borne by the State Government, and half by the Institute. The Chairman of the Western Australian Government Industries Assistance Board is a member of the Executive Committee of the Institute, his appointment having been made at the request of the State Government.

Both the South Australian and Tasmanian Governments are represented on the Advisory Council, and in both these States investigational work is being carried out.

The advantages of co-operative research between the Commonwealth and States cannot be denied. Broadly speaking, the individual States cannot afford the funds necessary for adequately tackling the larger problems, which are really national in their scope. The total cost of researches of a partial or fragmentary nature is many times greater than that of a comprehensive co-operative research led by the foremost experts in the particular field. The policy of the Government and of the Institute has always been directed towards co-operation with the States, and from the above it will be seen, not only that the States on their part have generously responded, but also that much has already been accomplished in the direction of co-operative enterprise.

—G. L.



E D I T O R I A L

THE BRITISH EMPIRE SUGAR RESEARCH ASSOCIATION.

The need for a British Sugar Research Association has so long been felt by sugar planters, refiners, and all those manufacturing firms directly and indirectly concerned with sugar that the formation of such an association as has now come into being will be welcomed.

With the assistance and support of the Government Department of Industrial and Scientific Research, a strong association has now been formed, whose articles and memorandum of association and prospectus have received the approval of that Department as well as that of the Board of Trade. On 30th May of this year this association was registered under the presidency of Sir George Beilby, who is a member of the Advisory Council of the Government Department of Industrial and Scientific Research. The vice-presidents are the following distinguished gentlemen:—The Right Hon. Lord Bledisloe of Lydney, K.B.E.; Sir Daniel Morris, K.C.M.G., D.C.L., D.Sc., LL.D.; Sir Edward Rosling; Professor E. J. Russell, O.B.E., D.Sc., F.R.S.; Professor W. Bateson, D.Sc., F.R.S.; Professor J. Bretland Farmer, D.Sc., M.A., F.R.S., and Mr. Edward Saunders. The gentlemen elected to the council represent every branch of the sugar industry throughout the Empire. The aim of the association is to establish, in co-operation with the Government Department of Scientific and Industrial Research, an Empire scheme for the scientific investigation, either by its own officers, or by universities, technical schools, and other institutions, of the problems arising in the sugar industry, and to encourage and improve the technical education of persons who are or may be engaged in the industry. The association is inviting all those who are engaged in any branch of the sugar industry within the Empire to become members, and thus become eligible for benefits resulting from the scientific investigations it will carry out. While it may be admitted that research work has always been proceeding in scattered localities of the Empire where cane and beet are grown, and also in England where sugar is refined, as well as in factories where sugar is an ingredient for the manufacture of the finished article, such research is carried out by the factory chemist, who works continually for the improvement of sugar manufacture. Such improvements, however, often remain only half investigated, owing to the time given to routine work, which is the main occupation of the factory chemist. There are few factories which can employ a highly skilled chemist mainly for research work; therefore, the necessity for an organized association where research will be carried out by the best brains for the general benefit of the Empire sugar industry is felt daily more and more. The scope of the work to be done by the association will include the investigation of problems arising in all branches of the sugar industry, including the

improvement of the sugar cane, sugar beet, the various methods of extracting the sweetening matter from cane and beet, the various processes of refining, and the best methods for the use of sugar employed by manufacturers using sugar as one of their raw materials, as well as the discovery of the best uses of the after-products of both factory and refinery. In order to make the research work of the association of the greatest possible utility to the industry power has been taken, not only to encourage the training of research workers, but also to improve the technical education of persons engaged, or likely to be engaged, in all branches of the sugar industry. A survey is being made of the field of research which is likely to be beneficial to the industry, and it is hoped that members of the association will be willing to assist in the framing of a thoroughly comprehensive scheme by making suggestions relating to that part of the industry with which they are intimately acquainted. It is also proposed to establish a bureau of information for the sugar and allied trades industries, to which any member of the association can apply for assistance in the technical and other difficulties which he may encounter in his business. By means of its various activities as an association for sugar research, a bureau of information, and a centre for the furtherance of technical education, it is hoped that the British Empire Sugar Research Association will exercise a far-reaching and beneficial influence on the future welfare of this ancient and important industry.—*The International Sugar Journal.*

AUSTRALIAN WOODS FOR TOBACCO PIPES.

The increasing scarcity of suitable woods for the manufacture of tobacco pipes has led to a number of inquiries being made of the Institute as to the suitability of Australian timbers for this purpose. Unfortunately, very little scientific information is available in Australia as to the possible successful utilization of Australian timbers for pipe making, and the subject is only one of very many which requires investigation. From time to time the importance of a forest products laboratory to Australia has been stressed in this journal, and this is but one of very many activities which might well engage the serious attention of such an organization. The timber relied on mostly for the purpose of local manufacture is known generally as the Australian mahogany, a species of eucalyptus, mostly obtained from Gippsland. Botanically, it is termed *Eucalyptus botryoides,* and it also often goes by the popular name of the laurel-leaved mahogany. There are several red mahoganies much similar, as, for instance, *E. robusta* (swamp mahogany), *E. marginata* (jarrah), *E. diversicolor* (karri). They occur in several parts of Australia. Though other woods have been employed, many have been rejected for various reasons. Some have been found to contain essential oils objectionable to the smoker, and others are found to burn too readily. On one or other of these grounds the employment of needlewood (*Hakea leucoptera*), redgum (*E. rostrata*), musk root (*Olearia angophylla*), and red myrtle or negro-head beech (*Fagus Cunninghamii*) have been tried, and, as a general rule, rejected. Considerable interest has also been manifested as to the value of tulip wood (*Harpullia pendula*), which occurs in Queensland and North New South Wales, but technologists are of opinion that they

are little, if any, better than musk root. With the clearing of so much of our valuable timber country for agricultural purposes, many of our most valuable timbers have almost disappeared, and there is certainly a very great shortage of them. Tulip wood, apart from any other consideration, would appear to have been ruled out because it is not now available in any large quantities.

ESSENTIAL QUALITIES OF PIPE WOOD.

The principal essentials for the manufacture of tobacco pipes are woods of sufficiently long and firm fibre, and of even colour, that can be thoroughly seasoned, and that do not contain an extra amount of cellulose material, thus becoming liable to burn. There is a widespread and general misconception that the imported pipes known as briars are made from the root of the English sweet briar (*Rosa rubiginosa*). As a matter of fact, they are generally made from the sweet heath (*Erica arborea*), and a native of Spain, Corsica, and parts of Africa. "Briar" in this connexion is, therefore, an English corruption of the French word "Bruyere." The sweet heath is a dense, heavy, and non-cleavable wood, and combustible with difficulty on account of the light content of silica. The shortage has led to all kinds of expedients, and in America the beech and the elm are being largely used for pipe making. Great numbers of pipes from these woods have already been sent to Australia, but they are not considered to be very satisfactory owing to the essential oils which they contain. Japan is also giving its attention to the manufacture of pipes, and there seems to be a general opinion on the part of the manufacturer that almost any sort of timber is suitable. The smoker, however, has other ideas on the subject. In his work on Australian hardwoods, Mr. R. T. Baker refers to the combustibility of certain pipe woods, and very many timbers are described and illustrated. The question of their seasoning and the colouring matter which they contain is already referred to; but, as Mr. Baker points out, very little is known of the chemical nature of the colouring matters. Mr. Baker's work may serve as a guide to those who are interesting themselves in pipe making in Australia; but, owing to the small amount of information available, it can only be accepted as a guide. The table of combustibilities, however, should be of special interest. Several of the highly resistant woods may become available for pipe making, as, in addition to combustibility, they work well and take a good polish. Such are *E. Fletcheri* (box), *Q. casuarina* (oak), *E. ovalifolia* (red box), *Cas. cambagei* (belah), *E. dealbata*, and *E. eugenioides* (stringybark).

FEEDING VALUE OF PRICKLY PEAR.

From time to time the merits of prickly pear as a feeding stuff for live stock are energetically urged, but investigations carried out in Australia—actual experiments with cattle and analyses of the pear—have so far failed to demonstrate the possession of any substantial food value. As a last resource, the pear is sometimes fed to cattle, and if the stock have not been allowed to decline into too poor condition, useful results, more particularly when the pear is combined with other fodders, have been obtained. Lately, there has been a revival of these claims on behalf of an American company. At the request of the Institute,

Professor Watt, of the University of Sydney, has made inquiries into the subject, and has reported that the process was evidently successful in removing the fibre, the prickles, and the tannin substances, but that the "grain" (the main product) has not a high feeding value, being poor in protein and having a calorific value lower than wheat straw. Professor Watt also stated that the two species chiefly used in America were quite different from the pear which has established itself over such a huge portion of the Commonwealth. As Professor Watt is visiting Great Britain shortly, travelling by way of the United States, he has been asked by the Institute to make full inquiries into the utilization of the pear as a food for stock.

THE GUAYULE RUBBER PLANT.

Some time ago the suggestion was made to the Institute by Mr. W. Ham, of the University of Adelaide, that research experiments might be carried out into the characteristics of Guayule (*Parthenium argentatum*) for rubber production. Mr. Ham pointed out that the plant was extensively grown in the arid portions of Mexico, and that large quantities of commercial rubber were now being made annually from this plant. In consequence of these representations, inquiries were addressed to the Bureau of Plant Industry of the United States Department of Agriculture for all information on the subject, with a view to a preliminary consideration of the question. Guayule, it appears, is a small woody shrub varying from 8 to 40 inches in height, with an average of 2 feet, having a much branched stem. It occurs over the "bush prairies" of North Mexico, and extends into Texas, New Mexico, and Arizona. The small leaves are greenish and silvery grey, as also are the younger twigs, which, as the age of the axis advances, change to light, then to dark ashy grey. The winter appearance of the plant is strikingly different from the summer appearance. In the winter, the leaves, saving those forming small clusters at the tips of the twigs, have fallen, leaving these bare. In summer, the new growths are clothed with leaves of maximum size, in which the green colour is more apparent. At this time, the flowers are borne in loose clusters on slender stems, and crown the plant with a profusion of small yellow blossoms. These are arranged in heads, each head resembling a small daisy, and capable of forming, at most, five seeds. Usually, some of these do not develop. A curious manner of development results in the association with the seed of a large amount of chaff. Guayule is distinct from most other rubber-producing plants, in that its bark contains no latex; rubber being in the cellular tissue of the epidermis, and, to a small extent, in the branches and leaves; the blossoms being without traces of rubber. The amount of rubber in the topmost branches is very slight, but increases towards the roots.

THE GUAYULE RUBBER INDUSTRY.

In a special report written for the Bureau of Foreign and Domestic Commerce, United States of America, in April, 1919, it is pointed out that the most important guayule districts command good railway facilities, although there are large areas whose exploitation is difficult

on account of the lack of means of transportation. These difficulties are mainly due to the fact that water for the pack animals cannot be found on these desert lands. The gathering is done under contract by natives, and the transportation charges sometimes run as high as £2 10s. per ton. Several large factories are now operating in Mexico. As far back as 1906 it was estimated that there were 310,000 metric tons of the shrub available, which would produce a yield of 33,000 metric tons of rubber. It has been found, however, that if, instead of the plants being pulled up by the roots, they are cut just beneath the surface, there is a fair prospect of the plant being reproduced. The self-sown seeds germinate uncertainly, and grow slowly. It is the question of the restocking of natural areas, therefore, that is giving rise to concern. One large operator, from experience gained in the past, counts upon an annual production indefinitely of somewhat over 2,000 tons. These figures are based on the supposition that guayule will not go below 9d. nor above 15d. per lb. Scientists, however, are now giving their attention to the question of the cultivation of guayule, and laboratories and experimental plots on a large scale have been established in California and Arizona. Some interesting results have already been obtained. The facts tabulated show that there is a wide difference in the amount of rubber in the different shrubs. This ran from 1 per cent. to 20 per cent., and in rare cases to 27 per cent. Improvement of yields by breeding, therefore, is engaging close attention. One remarkable result that has been obtained has reference to the length of time in which a plant will mature. The problem of speeding up the growth has been solved. Left to itself, in its desert home, under normal conditions, a guayule seedling takes some twenty years to arrive at maturity. Now, under artificial treatment, development has been accomplished in four years. Further inquiries into the general question have now been addressed by the Institute to Mr. W. B. McCallum, who is located at Tucson, Arizona.

AMERICA ENCOURAGES RESEARCH.

After some years' absence from South Australia, Dr. Thornburn Brailsford Robertson has returned to accept the position at the Adelaide University of Professor of Physiology. Dr. Robertson has been in the United States and in Canada since 1905, having latterly occupied the Chair of Bio-chemistry at Toronto. He has come back deeply impressed with Australia's need for original scientific research. "America, Canada, and Japan," he stated in an interview in the daily press, "are directly and indirectly our competitors. We must follow their lead in this matter, or else be hopelessly left behind in the severe competition we shall soon experience. America provides an abundance of money for research work, and in Canada industrial research is proceeding energetically. The Dominion Government has just put aside 1,500,000 dollars for building an Institute of Research in Ottawa, which will contain suites of laboratories where manufacturers working on similar lines may place staffs for research work. The Government provides elementary requirements, such as water power, gas, reference libraries, and so on, and the manufacturers are to provide the chemists and workers, &c."

THE ALERT JAPANESE.

While he was in California, Professor Robertson was brought into close touch with the Japanese, and when invited to give his experience of educational affairs in the land of the Lotus he said higher education and research work were going ahead with remarkable strides in Japan. "They are constantly sending men over to America," he continued, "to study American methods. The expenses of these men are paid by the Government. It is their duty to ascertain at first hand all they can about new methods and discoveries. If an American professor makes some discovery which promises to be of value, commercially and otherwise, before very long a member of the faculty of one of the Japanese Universities is waiting upon the American and requesting permission to work with him for a year or two. The Japanese learns all he can about the new process, discovery, or system, and then returns to his own land to use the information. The Japanese Government just before I left America set aside a million sterling for research in physics alone. That gives some indication of their alertness. There can be no question to-day about the value of this work. Industrial research has proved to be of the utmost value, and the development in America may be ascribed almost wholly to it. Great Britain has had her lesson also. When the war broke out she was using a substance known as acetone for making her nitro-glycerine explosives. It was made from waste wood. But all the wood in Great Britain could not have provided acetone enough. Her total output at the time was enough for only one day's fighting. At that time the wood process was the only one known for producing acetone, but a bio-chemist working in Manchester in research respecting the bacteria inhabiting soils—which did not appear to have any relation to high explosives—discovered a bacteria producing acetone from starch. From that apparently unimportant discovery came one of the great industries of the war, and that chemist, after having set the industry going in Britain, went across to Canada, took over a whisky distillery, added to it, and adapted it, and to-day that factory covers an entire city block, is five stories high, and gives employment to 2,000 persons. The great fact that must be remembered about research work is that it may prove of altogether unreckoned importance, and may give—as it has done hundreds of times—a new industry to the State and immense improvements to existing industries. That has been America's experience. Research work also fits men to grapple with old problems in a new and successful way. This work is necessary and justifiable in every sense. We can only meet our war expenditure and waste by making one hour's work produce what two hours' work produced before. This will be achieved by bringing trained intelligence to the assistance of labour. Half a century ago research was cheap, because apparatus was crude and simple. Now it is expensive because apparatus is complex and costly. The United States, Canada, and Japan have proved that research justifies very large expenditure."

EDITORIAL.

AN IMPERIAL AGRICULTURAL BUREAU.

At the recent meeting in London of the Imperial Education Conference, a strong opinion was unanimously expressed on the need for an Imperial Agricultural Bureau, the objects of which would be—

(1) To collect and to present in an available form information on the various agencies for agricultural education within the United Kingdom, the Dominions, India, and the Crown Colonies and Dependencies. One function of the Bureau would be to provide advice as to the education best fitted for an intending settler in any part of the Empire, to inform him of the facilities and their cost. The Bureau would also promote the interchange of teachers between institutions within the Empire;

(2) To perform a similar function with regard to agricultural research. The Bureau would draw up a synopsis of the existing research institutions, and of the work that had been done or was in progress. It would inform inquirers as to the most probable sources of advice on problems met with in practice, and would put individuals or commercial firms in touch with the investigators they require. The Bureau would be able to assist investigators in search of material, and promote their occasional interchange. The Bureau might publish a regular abstract of investigations, and from time to time a review of progress in particular directions;

(3) To collect and distribute information on the agricultural resources of the Empire for the service, on the one hand, of intending settlers and planters, and, on the other, for merchants and manufacturers. The necessity of this work is apparent from the consideration that agriculture is by far the largest industry within the Empire, and that in its diversity and varied character it covers almost the whole range of agricultural products.

It is suggested that the Bureau should be constituted on the lines of the Imperial Mineral Resources Bureau, and should similarly be under the Lord President of the Council. At the meeting referred to, the Board of Agriculture and Fisheries expressed their willingness to initiate the preliminary organization necessary for the formation of such a Bureau, and it is proposed to hold a Conference at an early date with the object of considering the subject and appointing an interim committee to take action.

WAR MATERIALS—NITROGEN FIXATION AND SODIUM CYANIDE.

Under this title, the American Department of the Interior, Bureau of Mines, has published a Bulletin giving brief accounts of the efforts of the United States authorities to supply from domestic sources those raw materials that are needed for the great industries, especially the war industries, and for which in pre-war times we had been largely, and, in some cases almost wholly, dependent on importations. The difficulty consisted, not merely in the shutting off of the supply from the countries at war, but the shortness of tonnage and the need of it for transportation of troops and supplies, still further emphasized the importance of domestic sources. Among the raw materials that were

especially the subject of these efforts are manganese, graphite, tin, mercury, potash, tungsten, molybdenum, antimony, chromite, magnesite, mica, platinum, and arsenic.

Acts of Congress constituting Commissions and Boards of Experts were passed, and many eminent engineers and chemists undertook investigations for deposits of the minerals from which the important products might be obtained. Studies were also made in regard to the several processes of nitrogen fixation. The Bulletin in hand is a preliminary report; in fact, is merely an advance chapter from Bulletin 178 of the Bureau of Mines.

One point of interest is worthy of special notice, namely, that the simple process of Bucher for the production of sodium cyanide has been shown to be practicable on the large scale. In this connexion, notice should be given to the success of methods devised by L. S. Potsdamer for recovering valuable materials from gas-mass; that is, the mixture of ferric hydroxide and wood chips used for purifying illuminating gas. This accumulates a number of by-products, among which are tar, sulphur, thiocyabides, ammonium salts, ferro- and ferri- cyanides, double ammonium cyanides. Potsdamer devised a plan of recovering these substances and reviving the gas-mass so that it could be returned to the purifiers. The details of the methods will be found in *Journal Ind. Eng. Chem.*, Vol. XI., p. 769, 1919.

FIXED NITROGEN RESEARCH IN THE UNITED STATES OF AMERICA.

In the United States further efforts are to be made to develop the nitrogen-fixation industry. A fixed nitrogen research laboratory has now been organized in the nitrate division of the Ordnance Department, in the head-quarters at the American University, in buildings formerly occupied by the Chemical Warfare Service. Lieut.-Colonel A. B. Lamb, of the Chemical Warfare Service, is director; Dr. R. C. Tolman, formerly of the Chemical Warfare Service, and Professor W. C. Bray, of the University of California, are associate directors; and Dr. H. A. Curtis, formerly of the Nitrate Division, Ordnance Department, is executive officer. The work carried on during the war on the fixation of nitrogen in the Department of Agriculture laboratories and elsewhere will be concentrated at the American University. At present the staff consists of fifty-five persons.

PRODUCER GAS FOR INTERNAL COMBUSTION ENGINES.

The shortage of motor spirit in Great Britain during the war led to extensive investigations for substitutes, among which were ordinary illuminating gas and producer gas. A report has just been published by the Committee appointed to investigate the subject, an abstract of which is given in the *English Mechanic* (Vol. CX., p. 31, 1919). The Committee considers that gas traction is as safe as the ordinary form, even when unprotected and exposed flexible containers are used. In its newer forms it is well worth consideration as an alternative of electric, petrol, or steam traction. Common city gas is estimated to be equivalent to petrol in the proportion of 250 cubic feet of the former

to 1 gallon of the latter. It is recommended, however, that gas-bags should be replaced by rigid or semi-rigid containers whenever a compression plant can be installed, but it is not considered advisable that any existing plant for gas traction should be abandoned at this time. Figures on cost of compressing, &c., are given, but they are obviously of no value in this country.

In a supplementary article, Mr. David J. Smith, who made many of the experiments in the matter, states that it is possible to run satisfactorily, in competition with petrol, motor vehicles by producing gas made on the vehicle, using anthracite, coke, or charcoal. He states that the cost of running a truck with anthracite at 50s. per ton was equivalent to petrol at 5.4d. per gallon, the commercial rate of the petrol being taken at 2s. 6d. (about 60 cents) per gallon. He claims that a producer can be made according to his designs that will occupy no loading room on the truck, and free access to the equipment is secured. In case of trucks, the weight of the equipment for producing the gas does not exceed 2 per cent. of the weight of the loaded vehicle. The method is applicable to boats and tractors; the small size of the plant rendering it suitable for applications to which formerly producer-gas apparatus could not be applied.

THE BRITISH NATIONAL PHYSICAL LABORATORY.

Sir Richard Glazebrook, who has resigned the directorship of the National Physical Laboratory, Teddington, is succeeded by Professor Petavel, Professor of Engineering and Director of the Whitworth Laboratory in the University of Manchester. The *London Times* writes—

> Sir Richard Glazebrook, who retires from the directorship of the National Physical Laboratory, has controlled its fortunes from its small beginnings in 1899 to its present great place in the scientific organization of the nation. It was first intended merely to carry out investigations required in connexion with the manufacture and testing of instruments of precision, and, in 1902, when it was moved to new buildings at Teddington, it had only two departments and a staff of 26. It has now seven scientific departments, a secretariat, and a staff of over 600 persons. These deal with heat, optics, acoustics, and molecular physics, with electricity, metrology, engineering, metallurgy, the forms of ships and aerial machines, and aerodynamics. It is the supreme scientific court of appeal and advice for all questions involving the physical properties of matter, the strength and qualities of materials, gauges and standards. During the war it rendered invaluable service. In the financial year ending in March, 1918, the Ministry of Munitions alone paid it £42,000 for work done, and when it is remembered that the expenditure was not on manufacture, but merely on examining and testing, some measure of its service may be gained. Until last year the Royal Society was the governing body of the Laboratory, and conducted its affairs with the assistance of a general Board of 36 members, of whom twelve were nominees of industrial and commercial institutions. It was almost an ideal

combination of science and industry, and Sir Richard Glazebrook gained the respect and admiration of his theoretical and practical masters. But the financial responsibility was heavy and increasing, and from 1st April, 1918, the Department of Scientific and Industrial Research took over the burden. Fortunately, under the new arrangement, the Department assumes only the control necessary for an accounting authority. Sir Richard will hand over to his distinguished successor, Professor Petavel, not only an institution of great and growing usefulness, but a tradition of harmonious co-operation between science and industry. He has provided the new Department of Scientific and Industrial Research with a working organization sufficient to justify their existence, and with a model on which we may suppose that their most successful creations—the Industrial Research Councils—have been formed.

MARINE RESEARCH.

A Committee of the National Sea Fisheries Protection Association has prepared a scheme for fishery research, statistics, education, and propaganda in the United Kingdom. The main recommendations of the Committee are as follow:—

(1) That the Government be requested to provide funds for a comprehensive scheme of research statistics for the fisheries of the United Kingdom on the lines set forth in this report.

(2) That each Fishery Department be provided with a suitable scientific staff under a scientific director with well-equipped laboratories, and with sufficient steamers for research work and for the exploration of our fishing grounds.

(3) That the Fishery Departments be requested to adopt the best means they can devise for securing the uniformity of fishery statistics, and the co-ordination of research work throughout the United Kingdom.

(4) That the Fishery Departments make suitable provision for the publication of scientific reports which are of importance to the industry, and, in particular, for the publication monthly of a fishery journal containing all information in regard to scientific results, statistics, statutes, orders, foreign intelligence, commercial information, and all other information likely to be of benefit to those carrying on the industry.

(5) That the Fishery Departments and the Education Departments of the three kingdoms be requested to co-operate in providing a scheme of education on the general lines laid down in the report.

NATIONAL SAFETY AND SCIENTIFIC RESEARCH.

The British Association, as an outcome of the comprehensive review of scientific work during the war, which formed a conspicuous part of the programme of the recent meeting in Bournemouth, has addressed the following resolution to the Prime Minister and the Treasury:—"The British Association for the Advancement of Science, in reviewing the

results of scientific method applied to military and other practical arts, recognises that the successful issue of the war has sprung from the efforts of scientific men concentrated on those problems, and with the conviction that the well-being and security of the nation are dependent on the continuous study of such matters, would urge on His Majesty's Government the necessity for apportioning an adequate sum from that allocated to home administration and the upkeep of the fighting Forces for the purposes of a definitely organized scheme of research, as, for example, on problems connected with health, food, and commerce, on explosives, on chemical warfare, and on physical and engineering problems bearing on military work." Similar resolutions, in varying terms according to the special cases, have been forwarded to the First Lord of the Admiralty, the Secretary for War, the President of the Board of Trade, and the Ministers of Health and Food.

RESEARCH IN NON-FERROUS METALS.

About a year ago, representatives of the non-ferrous metals industries in Great Britain held a meeting and decided to establish a Research Association under the British Department of Scientific Research, which, it will be remembered, has been provided with a fund of £1,000,000 to be expended on assisting scientific investigations of benefit to British industries. A scheme for carrying out investigational work has now been prepared, and provision is to be made for the establishment of a special Research Institute and Experimental Workshop. It is intended also to obtain quarters for housing an Information Bureau, to appoint a staff, and to establish branches in various centres of the country. The Bureau will be a storehouse of tabulated scientific and technical information collected from all available sources, and arranged in such form as to be of easy access and practical utility to meet the every-day wants of those engaged in the production, treatment, working, and use of non-ferrous metals.

PRODUCTION INCREASED BY PLANT BREEDING.

Reviewing the activities in the domain of botany in recent years, Sir Daniel Morris, in an address before the British Association quoted a number of striking instances where progress has been made in the improvement of cotton, wheat rubber, cocoa, &c. "One of the outstanding features that emerges from a record of botanical search during the last decade or two is the prominent position occupied by plant breeding on mendelian lines. In proof of this are the numerous well-equipped plant-breeding institutes established and maintained by Government and private funds. Plant breeding is now in the forefront in relation to the improvement of crops, and the value of it is officially acknowledged as a 'a vital element in the national policy.'" According to the Secretary of the Board of Agriculture, what we want "are new races of plants adapted to intensive cultivation," and he adds, "it is my deliberate opinion that an increase in the production of our land is much more easily attainable in that direction than in any other."

PEST PARASITES.

In schemes of intensive cultivation Sir Daniel Morris pointed out that it were well to bear in mind that it might be possible in some instances to go beyond what was necessary to achieve the object in view. The opinion was held by some that the more intensive the cropping the greater the opportunity for the various pests to live. Further, most pests have their parasites, and wholesale sterilization may help the pest by destroying the parasites. As illustrating this contingency, Sir Daniel mentioned the case of the Moth Borer attacking sugar cane in the West Indies. For probably something like 200 years the Moth Borer had been regarded as the most destructive enemy of the sugar cane. Its life history was unknown until Lefroy discovered the eggs which were deposited in a greenish cluster on the back of the leaves of the sugar cane. The egg clusters were so inconspicuous that they had entirely escaped notice. The first steps were to employ boys to cut off portion of the leaves with the eggs and burn them. It was afterwards discovered that many of the eggs were parasitized, and the planters were thus unknowingly destroying the parasite, and practically increasing rather than diminishing the attack of the Moth Borer. On the further advice of Lefroy the leaves with the egg clusters were not burned, but spread out in the shade to enable the parasites to hatch out, with the result that in the later stages of the crop nearly all the Moth Borer eggs were parasitized, and the loss in canes in that and the succeeding crop was largely reduced by natural means.

TASMANIAN TIMBER INDUSTRY.

Year after year, with the greatest regularity, each State Forestry Department directs attention to the importance of controlling our forests and of taking steps to provide for the future requirements of the Commonwealth. The latest annual protest from Tasmania against permitting further wastage of a rich asset is as follows:—"Although, as previously pointed out, there will not be any real shortage to meet the requirements of the State, so far as hardwood is concerned, for many years, yet as part of the Commonwealth it is desirable to look further afield to make up for any deficiency in the forest areas of the neighbouring States, and even for the export abroad of the world-famed eucalyptus timbers, to assist in supplying the want created by the awful forest destruction caused by five years' devastating warfare in the western parts of the Empire. For that reason it is essential that every reasonable care be exercised to preserve and to secure a fresh crop to take the place of the present stand when the latter has been utilized, keeping in view the fact that a fresh crop cannot be expected for general purposes within at least half a century. That is in regard to satisfying the demand for hardwoods only, but when we come to the larger question of supplying the requirements of the State and the Commonwealth in softwoods, the necessity for sending abroad over £3,000,000 a year for the imported article would have been obviated if the States had adopted a prudent policy of afforestation in the early days."

POTATO FLOUR.

Extraordinary development has taken place in Great Britain since the outbreak of war in the industrial use of potatoes. Under the direction of the British Farina Mills Limited a number of factories are being established in suitable agricultural centres for the manufacture of potato flour or farina. Each will be able to deal with 1,500 tons of potatoes per week, and already one or two are in operation. The special importance of this innovation to the agricultural industry is that a constant and steady market is assured to the grower, and a profitable means is also provided him of disposing of injured and even diseased potatoes. The value of damaged potatoes is assessed in relation to the starch contents of the portion of the tubers which are sound. Farina is principally used by the textile trades, and large supplies are also required for the manufacture of dextrine, and various classes of gums and other products of a like nature. In addition there are many uses for it amongst manufacturing chemists, some of these being the production of artificial sago and grape sugar. Prior to the war potatoes were used extensively in Germany, Holland, and in Japan for industrial purposes.

CHEMISTRY OF POTATO FLOUR.

Mr. H. W. Richards, in the October *Journal of the Board of Agriculture*, contributes an interesting article upon the manufacture of farina from potatoes. Contrary to the impression usually conveyed by the term "potato flour," he points out this product does not consist of potatoes dried and pulverized, but is the pure starch separated from the rest of the potato, and called farina. "The part played by starch in the life activity of the potato is of great interest. The substance is built up by the wonderful chemistry of nature from the simplest constituents of food and water drawn from the plant's environment. For the purpose of transport in the sap it is readily changed into the form of sugar, which is soluble, and can be conveyed to one part for growth and to another part for storage in reserve. In the latter case it is deposited as starch grains of microscopic size. This explanation makes clear the advantage in allowing the haulm to die down before the potato crop is lifted, so that the sap may be withdrawn to the tubers, and there deposit its strength as grains of starch." Mr. Richards explains that by means of auxiliary plant in these mills the potato residues, which still contain a valuable part of the nourishment, can be prepared as a feed for animals in a greatly improved form. Manufactured in a cooked and concentrated form it will keep in store indefinitely, and will prove a more digestible and healthy food than the raw potato, beside having a wider range of use.

BREAD FROM POTATO FLOUR.

Whether the time has arrived for Australia to consider the permanent establishment of a potato flour industry on a large scale is obviously a matter of economics. With the continuance of such a lucrative market for potatoes for purely domestic consumption awaiting

the grower as there has been of recent years, there is little immediate prospect of any supplies being diverted to the manufacture of starch. It certainly would not suit the growers to sell to factories while housewives are able to pay higher prices. In previous years, during a glut potatoes have frequently been unsaleable, and starch was then sometimes made on the farms. There is nothing complicated about the process, and all that is necessary to insure the success of a factory is a sufficiency and continuity of supply. Several State Departments in the United States have been studying the question of the suitability of potato flour for mixing with wheaten flour. Its use for this purpose does not lack advocates, who emphasize the wholesomeness of white bread when made from an appropriate mixture of the two flours. It is claimed that the potato on oxidation in the body produces an alkaline ash, while white flour on oxidation produces an acid ash favouring the production of acidosis.

FUMIGATION INVESTIGATIONS.

Fumigation is not yet practised to any large extent in Australia to combat noxious insects, but it is inevitable that much greater attention must be given to this question in the very near future. The rapid expansion of the citrus area and the opening up of new and widely remote areas is bound to be followed by the dissemination of red scale and other pests, and with a large increase in production the attainment of quality will have to be closely studied. In the United States radical changes are being brought about in the fruit, nursery, and grain industries by the use of hydrocyanic acid gas and carbon bisulphide, and since their general application, which dates back only nine or ten years, a great number of valuable investigations have been carried out at the different experimental stations. An important innovation is the use of liquid hydrocyanic acid in the place of the pot-generated gas. In the latest number to hand of the *Journal of Economic Entomology*, Mr. R. S. Woglum describes the results of extensive experiments, which included operations covering several hundred acres of orange and lemon trees, both large and small, infested with black and red scale. In this work liquid hydrocyanic acid, 95 to 98 per cent. pure, was used, the application being made in the form of a spray by special machines designed for this purpose. The comparative efficacy of the liquid hydrocyanic acid and pot-generated gas favours the former, so far as the bottom of the trees is concerned, but the total result for the whole tree is slightly favorable to the pot treatment, and shows that, under the stated conditions, 16.56 cubic centimetres of liquid hydrocyanic gas is insufficient to produce results equivalent to 1 oz. of sodium cyanide in pot-generation. In the case of the black scale the results indicated a decided economy of material over the requirements of pot-fumigated trees. To the Australian growers the chief point of interest lies in the fact that liquid hydrocyanic gas is being thoroughly tested, and that experiments have gone far enough to permit of a schedule being prepared for citrus-tree fumigation which will approximate uniform results in orchard treatment regardless of the size of the tree, and will prove fully as satisfactory as the original schedule prepared for pot fumigation.

EDITORIAL.

FARM TRACTOR TRIALS.

Deep interest has been aroused among agriculturists in a trial of farm motor tractors recently held in Lincolnshire. Although the official report is not yet to hand, some authoritative comments upon the tests have been made by Messrs. T. Close, B. J. Owen, B.Sc., and H. G. Richardson, M.A., B.Sc., and in a conjoint statement they remark upon two striking facts. With insignificant exceptions all the competing tractors ran practically continuously and without a hitch, and that a very large attendance was composed of farmers and others from all parts of the United Kingdom and abroad, not as spectators, but to obtain practical information as users, manufacturers, or officials. One noteworthy feature emphasized was that manufacturers have definitely departed from the idea that great weight is necessary, and are paying close attention to the reduction of weight. Beyond a certain point any increase of weight must clearly increase the liability of slipping on soft ground and decrease the ability of the tractor to climb gradients, besides increasing the risk of damage to the engine when stones are encountered. Considerable attention has also been given to rendering the vital parts of the machine more accessible, and to providing protection from the effect of weather and dirt.

CONCLUSIONS FROM THE TRIALS.

The conclusions arrived at were that the trials were of great value from a commercial and educational stand-point. It is difficult to conceive of a better means of demonstrating the articles which a manufacturer has to sell or of affording a would-be purchaser a ready means of determining his choice. It should, however, be borne in mind that the trials were by no means exhaustive or final tests of the value or capacity of any machine. They cannot from their very circumstances afford any evidence of the durability of a machine, nor are they in any case strictly comparative, since there is no uniformity of test or conditions. The very favorable weather conditions under which the trials were carried out, while most happy from a commercial and probably from an educational stand-point, in themselves lightened the task both of the machines and the operators. The fields were selected so as to give, as far as practicable, uniform soil conditions, but there was very considerable, although unavoidable, variation in the plots allotted to the different types. Another point worthy of notice is the presence of the expert operator at trials of this character, and the personal factor undoubtedly comes into play to a very considerable extent. There is room for tests of a rather different character, extending over a considerable period, and so arranged as to give approximate uniformity of task and conditions. In this way a standard of comparison could be instituted far more exact than is possible under conditions such as existed at the Lincoln trials, and the durability of the machines, of the first importance to farmers, could be evaluated. There is, however, room for both types of test, and neither could displace the other. The popular success of the Lincoln trials is undoubted evidence of the need for exhibitions of that character. It remains to add, states the report, that British manufacturers were well represented at the trials, and that the British-made tractors compared favorably in every way with the American tractors. Apart from

American machines, only one foreign type, the F.I.A.T., was entered; in future years it is to be expected that French and other continental manufacturers will be represented, and a great deal may be learnt both by British manufacturers and farmers who have hitherto in the matter of tractors gone to school almost exclusively in America.

AIR-TIGHT STORAGE DESTROYS GRAIN INSECTS.

It is concluded from experiments described in the Report of the Grain Pests (War) Committee that hermetical sealing will probably prove to be effective on a large scale as a remedy for badly-weeviled grain, as well as a preventive measure. The carbon dioxide given off by the grain as well as by the weevils themselves acts as a narcotic on the weevils, eventually killing them, but exercises no detrimental effect on the grain unless it is stored for longer than two years, when its germinating power becomes affected. The time taken to bring about the complete destruction of the insects seems to depend chiefly upon the relative volume of air present.

INSECT PEST CHANGES DIET.

A striking instance of quick adaptability to new food plants is furnished by the United States Department of Agriculture in a recent bulletin dealing with the grain bug (*chlorochroa sayi*). This bug has become a serious pest in many of the wheat and other grain-growing States of recent years, owing to the cultivation of large areas formerly devoted to grazing. The insect at once accommodated itself to the change from native weeds to succulent crops, and with better facilities for hibernation has increased in a marked degree. The young nymphs feed and develop on the young shoots of Russian thistle or other early developing plants, and upon reaching maturity the adults of the first generation migrate to fields of grain, and feed on the tender stems and heads until the grain ripens.

ANTI-MALARIA WORK IN THE ÆGEAN.

Malaria conditions in the Ægean Islands when the R.N.A.S. aerodromes and airship stations were constructed there in 1916-1918 were such that a very high sick rate was immediately reported. In one case a military guard of eighty-four was reduced to fourteen effectives after a few weeks, the malaria proving of a particularly malignant type. It was therefore decided to undertake drainage of the marshes before the summer of 1917. Supplies of quinine, netting, oil, paraffin, and implement were obtained. The channels were sprayed once a week, after clearing the surface of weeds, with heavy Burma oil, mixed in equal parts with low-graded paraffin, half a pint of the mixture being used per 100 square feet of surface. The first mosquitoes appeared in June, 1917, and no cases of malaria occurred until July, 1917. This was due to the bombing of the aerodrome, the men being compelled to spend several nights in mosquito-infested dugouts. By April, 1918, the marsh was completely dug, and no malaria occurred among the men. In describing this work the author mentions that satisfactory

results were obtained at Thasos, Kassandra, Stauros, Mitylene, Imbros, and Syria. The Greek population living in the proximity of swamps accept the malarial conditions and the consequent lowering of their vitality with characteristic indifference and fatalism.

POWER-ALCOHOL AND STARCH FROM MACROZAMIA.

In connexion with the investigations which the Institute has carried out regarding the macrozamia and the possibility of using this plant as raw material for the manufacturing of industrial alcohol and starch, it is interesting to note that, since the results of the investigations were made available, the Forestry Commissioners of New South Wales have invited tenders for the right to operate on Zamia palms, the price tendered to be at a rate per ton of dry starch obtained from the palms. The immediate practical value of the investigations is thus apparent, since important information was obtained regarding the starch contained in the plants.

ENTOMOLOGICAL RESEARCH IN ENGLAND.

The British Board of Agriculture and Fisheries has established an Entomological Laboratory at Rothamsted, where a Chief Entomologist and two research assistants are to devote their whole time to investigational work. It is also proposed to appoint twelve advisory entomologists, one for each of the twelve agricultural divisions in England.

CONCENTRATION OF SWEET CIDER BY REFRIGERATION.

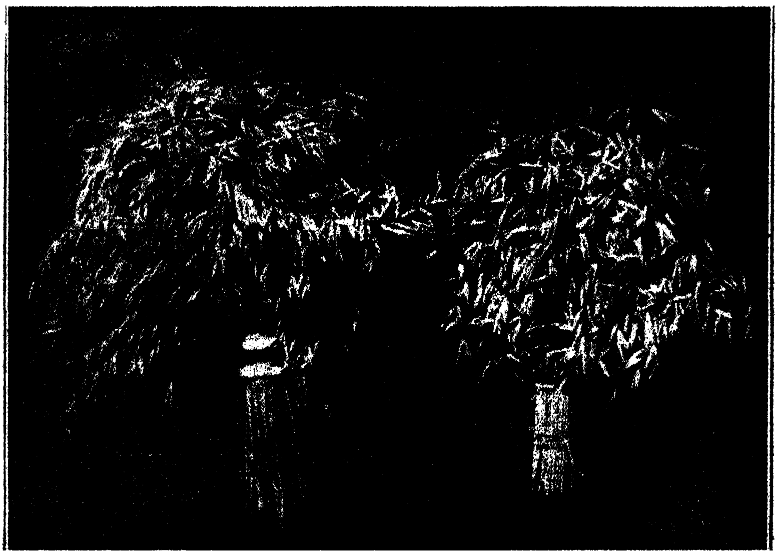
The Weekly News Letter of the United States Department of Agriculture for 10th September, 1919 (Vol. VII., No. 6, p. 3), describes a process by which sweet cider is concentrated by mechanical refrigeration. The fresh apple juice is frozen, and the frozen mass is crushed, then subjected to centrifugation. The frozen water is thereby separated from the mother liquor which contains the solid matter of the apple juice. Five gallons of juice yield 1 gallon of syrup concentrate. This concentrate has better keeping qualities than ordinary cider, and remains sweet indefinitely if kept in cold storage. By addition of water it may be restored to its original volume, condition, and flavour.

The Application of Electricity to Increase Crop Production.

By EWEN MACKINNON, B.A., B.Sc.

One of the main problems that England had to face during the war was the provision of an adequate food supply, not only for herself and her armies, but also for her Allies.

Since the armistice, the same problems of food supply still loom large before the Allies. This is due partly to the unsettled conditions in some of the large grain-producing countries, *e.g.*, Russia and Roumania, but also to the falling off in the average yields in some allied countries owing to adverse seasons, lack of suitable fertilizers, diseases, &c. Early in the war the plea was sounded for increased



TWO BUNDLES OF BLACK TARTARIAN OATS WITH 75 STRAWS IN EACH BUNDLE.
The improvement in straw and grain from the electrified seed is shown on the left.

production throughout the British Empire. There are two ways of increasing, viz.:—(1) By bringing a larger area under cultivation; and (2) by raising the average yield per acre of the land already under cultivation or about to be cultivated. It was chiefly by the first method that the great increase was obtained for 1915, though the second method did operate, but not from effort in that direction. Australia increased her area under wheat cultivation to 12½ million acres (previous greatest, 9.6 millions), which yielded 179 million bushels of wheat at an average of 14.34 bushels per acre. Since that year, both the total area and the

average yield have been receding to the pre-war averages (1904-14, 10.2 bushels). England, Canada, and the United States all had record yields in the same year, with a similar decline since, though the United States shows an upward tendency through 1918-19. In practically all the belligerent countries legislation had to be enacted during the war period designed to bring about further increased production. In England, the law of August, 1917, gave power to enforce the conversion of 3 million acres of grass land to cultivation. To further increase the yields, the selection of good seed was encouraged, and all grain for seed purposes could be officially tested. Even with these efforts there is room for enormous improvement in crop production, as a comparison of German, English, United States, and Australian averages will show. It behoves us, therefore, to use at the earliest opportunity every possible method of increasing this average. It is much more important, and promises far greater return, than increasing the total area under cultivation. What methods can we employ to reduce the gap between Australia's averages and those of England or Germany, or even of the United States of America? With the discovery of the value of superphosphate when applied to most Australian soils at a general rate of 56 lbs. to the acre in the case of wheat growing, our knowledge of fertilizers has practically remained stationary. Our manurial problems are not solved, and there are great possibilities in plant breeding, seed selection, and disease control. There has been little advance in breeding since Farrer's time.

Early Electro-culture.—Lemström's Methods.

We cannot say that the use of electricity as a stimulant to plant growth is new, as it dates back at least 150 years. Little was heard of it until about 1840, when interest was revived by the encouragement offered by the Highland Agricultural Society, and William Sturgeon, Lecturer in Natural Philosophy at the Manchester Institute of Science, described in the journal of that society a series of experiments carried out by him. At about this time, the advantages of using artificial fertilizers began to be made known through the work of John Lawes. The benefits to be derived from these quite overshadowed the problematical gains from the employment of electricity, and its use again fell into abeyance. From its next revival, due to S. Lemström, Professor of Physics at Helsingfors, Finland, we can date its permanent appearance. He carried on his experiments for twenty years—right up to the year of his death, 1905. They were carried out in Finland, England, Burgundy, in Germany near Breslau, and at Atvadaberg (Sweden).

His method consisted of conducting a current derived from a Wimshurst machine, through wires 18 inches above the ground. His researches show that overhead discharges affect a plant in all its phases—germination, vegetative growth, and maturation. He sums up his experiences in his book—*Electricity in Agriculture and Horticulture*—by stating that the best results are obtained—

(1) with the network positively charged;

(2) by applying the discharge in the morning and the evening;

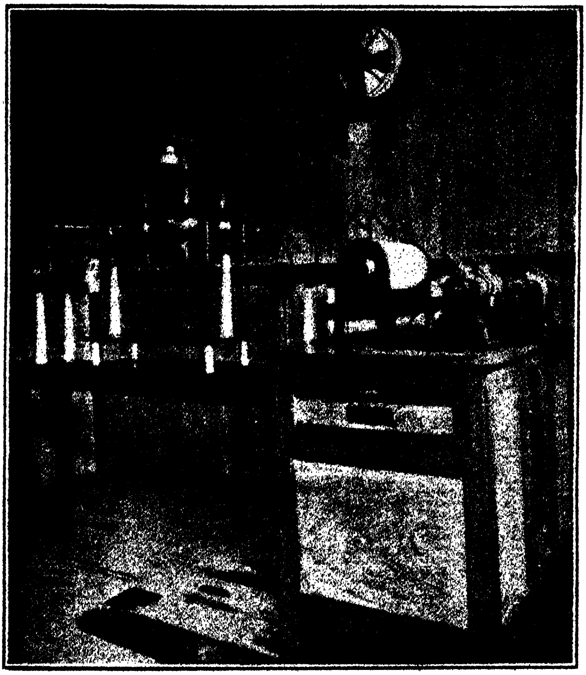
(3) by having the general conditions favorable for plant growth.

He used a current of about 1,000 volts.

It was Lemström who first suggested, from his observations on the growth of cereals under the influence of the Aurora Borealis, that the beards on the ends of most of the cereals might be a means whereby small charges of electricity are collected from the air and transmitted to the plant. He even contrived apparatus to prove the presence and measure the amount of such electricity round the grains.

Newman-Lodge Method.

Lemström's methods were displaced by the Newman-Lodge high tension system, and this is the method now adopted for most overhead discharge experiments. The current from a small dynamo, or from a town supply if available, is used to produce an alternating current by means of an induction coil. The negative current from the coil is led to the earth, while the positive current passes through a series of five or six vacuum globes, or Lodge rectifiers, and then to the overhead wires. The rectifiers work the pressure up to 100,000 or more volts. A system of poles is arranged round the field, one to the acre. Each pole is capped with a large porcelain insulator, and No. 18 galvanized wire is fixed round the field. Finer wires are stretched across at intervals of 30 feet, and about 15 feet above the ground.



THE INTERIOR OF THE SHED IN THE FIELD, SHOWING HIGH-TENSION APPARATUS.

This method has been followed generally since its introduction by J. E. Newman, of Gloucester, and Sir Oliver Lodge, on the property

of Mr. Bomford, at Evesham, in Gloucestershire. Other experimenters have modified the length of time of the current used. In the *Electrical Review* (London) 85, (8th August) 1919, details are given of the current, switches and motor, transformer, and Delon rectifier, which maintains a working pressure in dry weather of 39,000 volts D.C. A high-voltage transformer has been recently installed for the Purdue University (see *Electrical Review*, vol. 85, p. 363), which yields a current up to 600,000 volts.

Recent Advances.

V. H. Blackman and J. Jorgensen have gradually reduced the widths between their wires, which are silicon bronze, from 19 feet (1914),

OATS GROWN FROM ELECTRIFIED AND UNELECTRIFIED SEED.

LARGER STRAW AND EARS IN THE BARLEY GROWN FROM ELECTRIFIED SEED.

14 feet (1915) to 13½ feet (1916), and from 14 feet to 10 feet to 7 feet from the soil, and use a current of 9,000 volts in the wires. This was derived from a 3 amp. current at 50 volts in the primary coil of the induction coil, through a rotary mercury interrupter. These investigators have carried on their researches over a period of six years, and have considered the costs of the method, and conclude that the use of the overhead system is not yet sufficiently investigated to warrant its practical adoption on a large scale. It can be successfully applied to intensive market-gardening, especially with such crops as strawberries, tomatoes, potatoes, carrots, &c. In the case of leguminous plants, the immediate effect was harmful. There appears to be a "residual after effect," as leguminous crops on the same field not further treated give increased yields in the second year.

Some Practical Results from Electro-culture.

Some of Newman's results were as follows:—

Wheat—

Canadian Red Fife—

1906—From electrified seed	..	35½ bushels per acre.
From untreated seed	..	25½ bushels per acre.
1907—From electrified seed	..	41.4 bushels per acre.
From untreated seed	..	32 bushels per acre.
1908—From electrified seed	..	32.5 bushels per acre.
From untreated seed	..	26.2 bushels per acre.

English White Queen—

1906—From electrified seed	..	40 bushels per acre.
From untreated seed	..	31 bushels per acre.

Analysis also showed that the plants from the electrified seed yielded grain containing 11.15 per cent. dry gluten, and the untreated yielded only 10.35 per cent. This resulted in the electrified selling at 7½ per cent. higher than the untreated.

Other workers' results:—

Barley—

Lemström, 7 and 14 per cent. increases per acre.

Newman, 5 per cent. increase (would have been better only for previous bad preparation of soil).

Oats—

Lemström, average of 22 per cent. increase.

Newman, 6½ per cent. increase in grain, and 8 per cent. in straw.

Potatoes—

Miss Dudgeon—

Variety.

Ringleader, 8 tons and 5.8 tons per acre.

Windsor Castle, 11.7 tons and 9.8 tons per acre.

Golden Wonder, 8.7 tons and 8.1 tons per acre.

Great Scott, 11.8 tons and 10.3 tons per acre.

Lemström, 31 per cent. and 15 per cent. increases.

Blackman and Jorgensen, various, 20 per cent. and 50 per cent. increases.

Strawberries—

Lemström, 37 per cent., at Durham; 50 per cent., at Breslau.

Blackman and Jorgensen, 80 per cent. increase with young plants; 25 per cent. and 30 per cent. increase with old plants.

The Possibility of Disease Control.

There is one other aspect that promises results of considerable economic importance. It is the matter of disease control. In a set of experiments with cucumbers in 1904, J. E. Newman found all his plots attacked by Spot disease. Those plants, under the influence of

the discharge, were much less affected than the others. Professor Priestley, who examined them, stated that the ravages of the disease were largely inhibited by the electrical discharge, for during one week, when the influence machine broke down, the disease progressed more rapidly under the wires, and was again checked in re-starting the machine.

A Classification of the Various Methods.

We might conveniently classify the various methods for applying electricity in crop production into five groups, as follows:—

(1) Methods in which atmospheric electricity is collected and discharged to the crops.
(2) Methods in which electricity is generated by some machine (Wimshurst dynamo), or from some commercial supply, and distributed to growing crops.
(3) The electrification of the soil, or the plant or seed through the soil.
(4) Prolonged exposure to electric arc light, or mercury vapour lamp (rich in ultra-violet light).
(5) The electro-chemical treatment of the seed before sowing.

Use of Atmospheric Electricity.

In the first method, the electricity is collected from the air by a number of lightning conductors, either on special high towers built up for the purpose (*e.g.*, Berthelot's, at Meudon, in France), or on tall posts well insulated with very large insulators at the top. In middle and southern France, which is subject to hailstorms, lightning conductors of gilded electrolytic copper, raised 100 feet, often protect an area of about three-quarters of a mile all round each pole, and by conveying the electricity from the air to the ground, frequently disperse an impending storm. Many vineyards are thus saved, and the electricity is used in stimulating the growth of the plants so saved.

The Basty method is to collect atmospheric electricity by means of iron rods (¼-in. to ⅛-in. diameter), ending in a non-rusting point, and driven into the ground 8 or 10 inches, according to the length of the roots of the plant to be treated. For vegetables, the rods should stand about 3 feet high, and for wheat about 6 feet. Action is exerted over a radius of ground surface equal to the height of the rod. Some of Lieutenant Basty's results in 1913 were so marked (potatoes, 73 per cent. increase; beets, 66 per cent.; hemp, 328 per cent.) that the French Department of Agriculture took the matter up from the scientific stand-point.

Electrification Through the Soil.

The electrification of the soil has been attempted by many experimenters for a considerable number of years. A common method is to pass a current of electricity from some external source through the soil between electrodes buried therein. In greenhouse work, not much success was obtained until the adoption of the carbon electrode, which does not react with the soil and the resulting products from electrolytic decomposition, as the earth acts as an electrolyte. A recent method that has good prospects is one in which electrodes are placed 6 inches

deep along the sides of the field, and a high-tension current is sent through the soil. The seed is coated before sowing with a finely-divided, non-deteriorating metal. It is claimed that the cost is less than 50 cents per acre, and the net cost of the apparatus installed only £250. Other investigators have examined the result of electric treatment on the bacterial changes. I do not propose to discuss any of the theories on this section, and will refer those interested to two articles:—

(1) Electro-culture of the Soil, by Dr. Löl, Sc. Am. Supt. 79 : 151.

(2) The Theory of Electro-culture, by Rob. D. McCreery, Sc. Am. 120 : 530.

Effects of Electric Light on Plant Growth.

Experiments with *lights* of various kinds have been mostly confined to greenhouses where the exposure is under control, and the plants can all be subjected to the same conditions of temperature and moisture.

The electric arc light, and the mercury vapour lamp (rich in ultra-violet light) have been used, and, as a rule, the results may be summarized as follows:—

Total yield is increased, quality improved, and maturity is hastened.

Some plants, if too near the light, have a tendency to run to seed (*e.g.*, cress, lettuce, spinach). Lettuce within 3 feet were killed outright. There is a greater depth in colour, and in some peas examined the stems of the treated plants were more sturdy, and showed a larger percentage of fibre.

This method must necessarily be limited in its application, though there are great possibilities with all kinds of greenhouse or hothouse work.

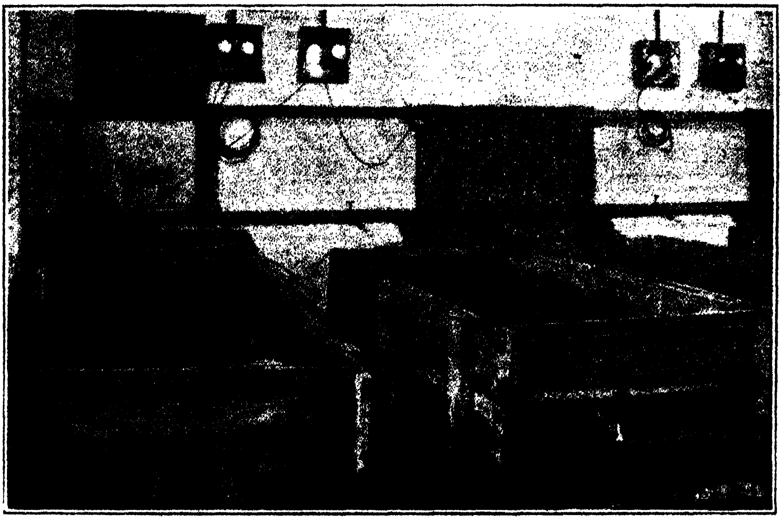
Electro-chemical Treatment of Seed.—Early Work in Australia.

The difficulties and the expense of subjecting growing crops to the application of electricity, either continuously or at intervals during their growth, induced H. E. Fry, an electrician, to experiment with the electrification of seeds. Though this is considered a virgin field by most writers who have published his methods, experiments were carried out over several seasons in South Australia by Butterfield and by Barclay, and some work was also carried out at Hawkesbury Agricultural College, New South Wales. In South Australia, an ordinary medical coil was used to electrify the seed for three or five minutes steeped in a solution of copper sulphate. Barclay is said to have increased his yield by 40 per cent.* Fry probably did not know of this work, and he was anxious to prove the practical value of his process by persuading farmers to give electrified seed a fair trial, and reserve the scientific aspect for future investigation by scientists. The methods are extremely simple, and his results have been so positive during the last few years, that there were 2,000 acres recorded as sown with electrified seed in England before 1919. His methods were spread only by farmer to farmer, mostly as a result of their own successes.

* See *Ag. Gaz.* N.S.W., vol. xix (1908), p. 874.

Fry's Methods.

The method finally adopted is simple in practice, and requires very little equipment, though care must be taken in carrying out the whole process.* A current of electricity will not pass through a heap of dry seed, so a solution of some substance is used to produce an electrolytic solution, in which the seed is soaked in a large wooden vat, holding ten to twenty sacks of seed, while a current of electricity is passed by means of two large electrodes (often an iron plate at each end of the vat). The current used is from an ordinary town supply, or from a dynamo, and a rheostat is used to regulate the voltage. After treatment the solution is run off, the seed taken out and dried, and it is then ready for planting. The salt used in making the solution is important. At



ONE OF THE FIRST COMMERCIAL INSTALLATIONS FOR ELECTRIFYING SEEDS.
Fitted up by Mr. Foot, a corn merchant, of Dorchester, with current from the town supply.

first the chemical fertilizers, such as sodium nitrate, ammonium sulphate, &c., were used. In some particular kind of soil, a calcium salt may give the best results with one seed, say oats, while a sodium salt may give the best results with barley. Again, a potassium salt may be best with wheat on one soil, and a sodium salt with the same wheat on a different soil. Other variable factors are the strength of the solution, the length of time for treatment, and the strength of the current to be used.

Barley, *e.g.*, requires treatment twice as long as either oats or wheat. It would appear that each kind of seed requires its own special treatment, and the methods have been worked out chiefly for wheat, oats, and barley during the last five or six years, chiefly in Fry's laboratory, at Godmanstone, in Dorset. The drying is very important, for, if the grain is overdried, it will be killed, and if underdried considerable damage is done to the germination. The seed should be sown within a month after treating.

* See (New Book)—*A Manual of Electro-chemical Treatment of Seeds.* Dr. C. L. Mercier. 134 pp. Univ. of London Press, 1919. 3s. 6d.

The Board of Trade has investigated the method and the results, but is not prepared to say how much of the success is due to the soaking in the chemical solution and how much to the electrical treatment. Various agricultural societies have had reports from special committees, and experts from abroad have also examined the fields scattered over many parts of the country, from the infertile and newly-ploughed heaths of Dorset to the chalk around Salisbury Plain, and the stiff clays of Cheshire.

Practical Results forom Fry's Method in England.

The seed was divided, one-half treated, and all sown and grown under the same conditions in each particular case, by practical agriculturists under ordinary farming conditions.

Some of the chief results by different farmers were as follows:—

	Gains per Acre.		Gains per Acre in Straw.	
	Bushels.	Bushels.	Tons cwt.	Tons cwt.
Wheat ..	(1) 7 ..	(2) $6\frac{1}{2}$ ..	(1) 2 8 ..	(2) 1 1
Barley ..	(1) 16 ..	(2) 18 ..	(1) 0 9 ..	(2) 0 10
Oats ..	(1) 6 ..	— ..	(1) 0 4 ..	—

Other gains were:—

Wheat .. $8\frac{1}{4}$ bushels; $5\frac{3}{4}$ bushels.
Oats .. 12, $19\frac{1}{2}$, 18, and 5 bushels.

The general results may be summarized thus:—

(1) The electrified seed in all cases gave an increased yield in bushels per acre varying from 25 to 37 per cent. The average for the 1918 season was over 30 per cent. increase.

(2) The electrified seed yielded a better quality grain ranging from 1 to 4 lbs. per bushel heavier. This means better milling quality, more flour, and less offal.

(3) The straw averaged from 2 inches to 8 inches longer than the untreated.

(4) The electrified gave stouter straw (an excess of 26 per cent. of that measured), and hence could stand up better.

(5) The tillering of the plant was greater from the treated seed, and it produced more ears of wheat and barley, or panicles of oats. Thus thicker plants with longer and stronger stems gave the increased yield of heavier grain.

Can Rust be Controlled by Electrical Treatment?

At the farm of W. E. Pledge, at Elmstead, near Ashford, in Kent, a remarkable example of rust resistance was seen, which, if supported by future tests, will considerably affect agricultural practice. A field of 8 acres had been sown with red standard wheat in October, 1918, one-half treated and the other untreated by electricity, but all sprayed with copper sulphate solution to prevent rust. The land was very poor, but the treated seed produced far more vigorous plants. The untreated would return not more than the 3 bushels per acre used to sow it; whereas the treated would yield a profitable return to the farmer. The untreated

was affected with rust so badly that it could be picked out readily from the treated, which was seen, on very close examination, to be scarcely affected by the disease, though it was open to infection all the time.

If electro-chemical treatment will produce rust resistance in wheat and other cereals, and possibly blight resistance in potatoes, &c., its importance can scarcely be exaggerated—the increase in production and the saving of human labour would be almost incalculable.

Dr. Brenchley reported that some pot experiments had been made over two years at Rothamstead, but that she found little difference between the plants at harvest time. Dr. Anderson stated, however, that, although results appeared identical, it had been found that in both years, when the grain was threshed and weighed, the results were very different, as much as 25 to 30 per cent. in some cases. The question of the effect of various soils was not sufficiently known, and in one year the potatoes at Rothamstead were not good. The trials at Wye for the

AN EQUAL NUMBER OF CULMS AND HEADS OF WHEAT ELECTRIFIED AND UNELECTRIFIED.

year 1918 were reported by G. H. Garrad as a failure; but it appeared that the results from the treated seed for 1919 would be better, as the two sets were apparently level towards harvest time.

It is admitted that the rationale of the process is not yet understood, though many theories have been advanced, involving ionization, permeability, osmotic pressure, sterilization, &c. Many details require working out, but there are sufficient practical results to justify immediate use of this method of electro-chemical treatment.

Some Problems Awaiting Solution.

The method of overhead discharge still requires much experimental and research work to solve some of its many problems. These are essentially problems of plant physiology. The question of an adequate and cheap source of electric power will be a great barrier for its extension in Australia.

It is desirable to try the different intensities of electricity under varying conditions of cultivation, moisture, of air and soil temperature, variations of soil and fertilizer, &c., all in the same season. There has been too little systematic variation of such conditions, provided with adequate controls. There has been a failure to realize the necessity for quantitative measurement of the electric discharge; that a stimulus may act differently on the plant at different stages of its life; that the effect of the stimulus depends on its intensity, and also on the time for which it is applied; and that the effect of the stimulus may appear a considerable time after its application. We do not know why the application is often most valuable on dull days, and may be deleterious as over-stimulation in bright sunlight or drought.

Though we do not know the manner in which the electrical discharge acts on a growing crop, this should be no bar to its use, as there are already in many directions substantial advantages to be derived. With the advances that have been made in internal combustion engines, and compact lighting plants with direct coupled dynamos, the electric supply may be overcome. In the new method of seed treatment, there is no necessity for an extensive plant. The seed can be treated in a central establishment, and after drying can be delivered to the planter.

Action taken by the United States of America and English Board of Agriculture.

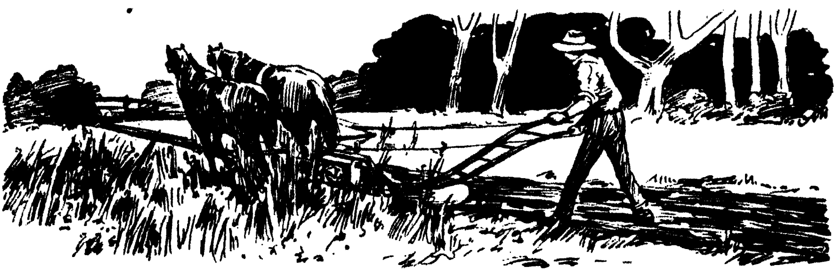
Most of the treated grain sown on the 2,000 acres in England was treated at one place. There the process is beyond the experimental stage as far as the farmer is concerned. It is now so established that this year (1920) the amount of seed that will be electrified will depend only on the capacity of the plants available to treat it. Dr. Wray, the United States Inspector in charge of their interests in Great Britain, has advised his Government to have immediate trials made in every State in the Union. Furthermore, the President of the Board of Agriculture and Fisheries has appointed a Committee to advise in regard to all electrical questions connected with the carrying out of experiments in electro-culture, and particularly with regard to the construction of apparatus suitable for use on an economic scale, and to the making of such electrical measurements as may be necessary in connexion with the experiments. On that Committee, we find Sir John Snell (chairman), Professor V. H. Blackman, Dr. E. J. Russell, Dr. W. H. Eccles, Professor T. Mather, and others.

Will Australia again Neglect Local Science?

In the face of such activity on the part of England, France, and the United States of America, shall Australia fail to move in the matter, and move quickly? Though we do not know the scientific explanation of the action, further trials are not likely to teach us much more. We

do not yet know the scientific basis of rust resistance, yet we do not stop breeding experiments which aim at producing a rust-resistant plant. We know that such a plant may be evolved. It will take years of careful scientific investigation to discover the cause of increased yield and of disease resistance.

There will probably be a much reduced area under cultivation this year owing to the prolonged drought, and the average yield has been steadily receding to the pre-war average for ten seasons (1904-14—10.2 bushels). The method of electro-chemical treatment of seed affords an opportunity of increasing this average. The initial cost is not great, and the potential gains are enormous. An Australian (Butterworth—since deceased) blazed the track twelve years ago in South Australia in the method already becoming known abroad as Fry's.



Activities of the Institute.

IMPORTANT INVESTIGATIONS.

A review of the record of work performed by the Institute of Science and Industry during the last three months discloses important advances in several of the investigations which are being carried out.

PRICKLY PEAR.

The Commonwealth Government and the State Governments of New South Wales and Queensland having agreed to the scheme for the investigation of the prickly pear problem proposed by the Institute, involving an expenditure of £8,000 per annum for five years, the question as to what steps should be taken to bring it into force has been fully and carefully considered. The scheme provides for the appointment of a biologist at a salary of £1,200 per annum to control the scientific work, and a recommendation has been made that Professor T. Harvey Johnston, Department of Biology, Queensland University, be appointed to that position. A small Special Committee, consisting of the chief officer of the Institute and a representative of each of the States of New South Wales and Queensland, has been appointed to control the business side of the investigations.

BLOWFLY PEST.

Substantial progress has been made with the inquiries into the sheep blowfly pest. The Institute has been in communication with Professor Lefroy on this matter, and has made a grant of £100 for further inquiries before introducing the parasites into Australia. A report has been received from Professor Lefroy on steps to be taken for receiving the insects in Australia. A further report as to the nature and habits of the parasites is expected. Every precaution will, of course, be taken before recommending that any parasites be liberated, or even introduced experimentally into this country, and the Institute will work in full co-operation in this matter with the Quarantine Department. In New South Wales experiments are now being carried out to test on a large scale results previously obtained. This work is being performed in co-operation with the New South Wales Department of Agriculture. Experiments at Roma, Queensland, are also being followed up. The effect of Chalcid wasps, which destroy the larvæ of the flies, is being tested, and highly encouraging results have been obtained from the jetting of the sheep with a dip containing arsenious oxide in solution. A brief report of the work was published in *Science and Industry*, No. 8.

ACTIVITIES OF THE INSTITUTE.

WHITE ANT PEST.

Arrangements have been made for experimental work regarding the white ant pest in co-operation with the New South Wales Department of Agriculture, and a Special Committee has been appointed. An abstract of information on the subject has been prepared for the use of members of the Special Committee, which will hold its first meeting to formulate a scheme of work at an early date.

WHITE EARTHENWARE INVESTIGATION.

Highly encouraging results have now been obtained from the laboratory experiments which have been carried out at Ballarat into the manufacture of white earthenware. It is now desirable to continue the tests on a larger scale, and for that purpose the Minister (Mr. Massy Greene) has agreed to an additional grant of £250 for the purchase of further apparatus and equipment. The Ballarat School of Mines and the Eureka Pottery and Tile Company are co-operating in the work, and are lending apparatus. If results already obtained are confirmed, there is every prospect of establishing the manufacture of high-grade white potteryware in Australia. Similarly in Western Australia a large amount of experimental work has been carried out into the suitability of various clays. The results are now being co-ordinated with a view to their publication. Already considerable assistance of a practical nature has been given to persons engaged in the pottery industry. The work is being carried out in co-operation with the Western Australian Government.

WORM NODULES IN CATTLE.

The Special Committee in New South Wales inquiring into worm nodules in cattle has obtained additional evidence as a result of the experimental work with regard to what had been previously found, viz., that the intermediate host must be a flying insect, and is probably a species of march-fly. It is hoped that the experimental work now being arranged for the forthcoming fly season will definitely settle this question.

STARCH FROM ZAMIA PALM.

At the Sydney University investigations by Dr. Harker on the utilization of the Zamia palm as a source of industrial alcohol or starch have been completed. They show that yields obtainable are very similar to those obtained from potatoes. Largely as a result of these investigations the New South Wales Forestry Commissioners have called for tenders for clearing lands covered with macrozamia, and it appears likely that the plants will be used for the manufacture of starch on a commercial scale.

ENGINEERING STANDARDS ASSOCIATION.

The standard specifications and drawings for structural steel sections, railway rails, and tramway rails have been completed, and are now in the printer's hands. The standardization of these three materials alone will result in large economies, and will enable Australian manufacturers to supply local requirements to a much larger extent than hitherto. Recently a representative of the Institute attended the first

council meeting of the new Institute of Engineers of Australia, which has agreed to the Institute's proposals for the establishment of an Engineering Standards Association. A recommendation on this matter will be made to the Government at an early date. The Institute has been asked to undertake the preparation of standard specifications (1) for cement, and (2) for carriage and waggon builders' materials, and the necessary information is being collected with a view to convening standardization conferences on these two matters.

UTILIZATION OF KELP.

A Special Committee in Tasmania has concluded its work upon the utilization of kelp. The conclusions are negative, and there is no immediate likelihood of the utilization of kelp industrially.

FOREST PRODUCTS.

Arrangements are being made for the extension of forest products investigations. The New South Wales Forestry Commissioners have agreed to co-operate with the Institute, and a scheme of work is being prepared. Mr. I. H. Boas, who has visited forest products laboratories in America, Europe, and India on behalf of this Institute and the Western Australian State Government, returned to Perth on the 26th December, 1919. A report is in course of preparation.

CATTLE TICK.

The Special Committee in Queensland on the Cattle Tick has completed its work in regard to the life history of the cattle tick, and has presented a preliminary report. Results have been obtained of much importance in connexion with the question of quarantine and steps to be taken for eradicating the tick. The results were published in *Science and Industry*, No. 7. The New South Wales and Queensland Governments have agreed to co-operate with the Institute in investigations on cattle tick dips. The work will be carried out in Queensland.

CASTOR BEANS.

Experimental work with a view to establishing the cultivation of castor beans in Australia has been initiated by the Institute in co-operation with the Queensland Acclimatisation Society.

VITICULTURAL PROBLEMS.

All the necessary arrangements have now been completed, and a commencement has been made with the problems embraced in the scheme of viticultural investigations to be carried out by the Institute in co-operation with the Mildura and District Research Committee. The problems include physical and chemical, as well as pathological and entomological research, and are directed to the discovery of remedial measures for some of the more serious troubles that afflict the vignerons of Australia. Information on this matter was published in *Science and Industry*, No. 8. The Institute is also considering proposals made by leading wine-growers for investigations on the cultivation of yeasts and certain bacterial problems affecting the wine industry.

ACTIVITIES OF THE INSTITUTE.

XANTHORRHŒA RESIN.

The Special Committee in South Australia which is making a fundamental investigation into the composition of Xanthorrhœa resin has completed the first stage of its work. An investigation of this nature is necessary as the first step towards the commercial utilization of the resin. The results obtained are of a highly technical nature, and will be published in the *Journal of the Society of Chemical Industry*, London.

COTTON GROWING.

The question as to what steps should be taken to develop the cultivation of cotton in Australia has been carefully considered, and the advice was obtained of the Queensland State Committee and of the Queensland Department of Agriculture and Stock. A recommendation was made that the Commonwealth should guarantee a price of 4d. per lb. for seed cotton grown in 1920. This recommendation was approved. Steps have been taken to obtain for experimental purposes from the United States of America, the West Indies, and Egypt samples of cotton seed free from insect pests and anthracnose or bacterial blight.

TANNING INVESTIGATIONS.

Important progress has been made in the work which is being carried out in co-operation with the Sydney Technical College to devise standard and up-to-date methods of tanning. A report has been prepared for publication as one of the Institute's bulletins. Further, the Special Committee in Queensland has devised a method of getting rid of the objectionable red colour in mangrove tanning. The question of carrying out further large scale experiments is under consideration. It is anticipated that results of much value to the tanning industry will be obtained.

PAPER PULP.

Valuable results having been obtained from experimental work on paper pulp from Karri, the executive has recommended that a grant of £150 be made for experiments on the pulping qualities of jarrah to be carried out under the Western Australian Conservator of Forests.

STOCK DISEASES.

Professor Dakin, University, Western Australia, has undertaken during his forthcoming visit to Europe to obtain complete information for the Institute regarding investigations on the Braxy diseases of sheep, and arrangements have been made to carry out investigations at the Melbourne University Veterinary School on certain aspects of contagious abortion in cattle. Proposals made in a despatch from the Colonial Secretary have been carefully considered, and a recommendation made for the appointment of representatives of the Commonwealth on the Committee of the Imperial Bureau of Mycology.

CONFERENCE OF SCIENTIFIC BODIES.

During September a large and representative conference of delegates from over thirty scientific, industrial, commercial, and technical associations and societies was held in Sydney to consider what steps could

be taken to expedite the establishment of the permanent Institute and to co-operate in its work. A resolution was passed urging the Government to establish the Institute on a permanent basis at an early date. At a further meeting, at which a representative of the Institute was present by invitation, the question was considered as to what steps could be taken to co-operate with the Institute. It was decided that no such steps could be usefully taken until the Bill to establish the permanent Institute is passed. These conferences were convened by the New South Wales Director of Education, and reflect the feeling of kindred organizations in other States regarding the necessity for the early foundation of the permanent Institute.

Welfare Work.

A bulletin was published on welfare work, setting out what has been done in regard to "industrial welfare" in Europe and America. There has been a very large demand for copies of the bulletin. A second bulletin on "Welfare Work in Australia" is nearing completion.

Miscellaneous.

A large number of miscellaneous matters, many of which involve a considerable amount of inquiry, was dealt with. Among them the following may be mentioned:—Imperial Entomological Conference—Representation of the Commonwealth; Gas Masks for Mine Rescue Work; The Utilization of Straw and other Fibrous Material for Manufacturing Butter Boxes; Pearl Shell Industry—The question of closing down Pearl Beds; Sandalwood Oil—Production of Australian Oil to conform with British Pharmacopœia Standard; Standardization of Nomenclature of Economic Plants of Australia; Scientific Research in British Colonies and Protectorates—Despatch from Colonial Secretary; Application of Electricity to Increase Crop Production; Standardization of Roofing Slates; The Utilization of Prickly Pear by a Patent Process; Citrus Canker in Fruit Trees; The Kimberley Horse Disease in Western Australia.

Posidonia Fibre.

An exhaustive investigation has been completed into the properties of Posidonia fibre, which is found in very large quantities around the coast of South Australia. Important results have been obtained, and are being followed up by the companies operating the fibre. It is anticipated that the industrial benefits resulting from these investigations will be of considerable importance.

Seed Improvement.

Progress has been made by the Inter-State Committee which is carrying out investigations with a view to improvement in the seed sown for the cultivation of cereal crops. The Committee has completed the first section of its work, relating to all the more important varieties of wheat, and a report on the matter is nearing completion.

ACTIVITIES OF THE INSTITUTE.

Mechanical Cotton Picker.

As a result of the laboratory tests carried out at Brisbane, a mechanical cotton-picker has been constructed with a view to carrying out field tests. Arrangements have been made for cultivating near Brisbane tractable varieties of cotton specially suitable for treatment by mechanical means. Owing to the adverse season, cotton planted for experimental purposes has not come up satisfactorily, and the work has thus been delayed.

Catalogue of Scientific Periodicals.

A catalogue embracing the whole of the scientific periodicals to be found in various libraries in the Commonwealth is now almost completed, and will be of very considerable value to scientific workers and in connexion with industrial scientific research in the Commonwealth.

Indigenous Grasses.

The Inter-State Committee which is dealing with the collection, propagation, improvement, and cultivation in suitable areas of the most promising indigenous grasses and fodder plants of Australia has made valuable progress in its work, and has completed the first stage of its investigations.

St. John's Wort.

Preliminary investigations are being carried out by the Institute in co-operation with the Imperial Bureau of Entomology, London, on the subject of insects which feed on and destroy St. John's Wort. If these preliminary investigations result favorably steps will be taken to prove definitely by properly designed experiments whether the liberation of the insects in Australia would involve any risk to crops.

Fuel Economy.

A considerable amount of preliminary work is being carried out in the direction of collecting data and preparing abstracts of information on the subject of fuel economy. In view of the magnitude and importance of the problems involved, it is impracticable to make any substantial progress in this field of work until the services of a full-time qualified technical assistant can be obtained.

Power Alcohol.

A demonstration recently given in Adelaide at the request of the Motor Traders' Association has excited a great deal of interest in this subject. A similar demonstration has just been given at the motor show in Sydney, and the Motor Traders' Association of Victoria has asked the Institute to arrange for a demonstration in Melbourne. This will be done.

Fast Doughs and Bread Making.

Investigations are being carried out in the bakehouse of the Sydney Technical College under trade conditions into fast doughs, and represent the application of the results of the experiments previously carried out

in the laboratory. The results of this work show that the time occupied in making the bread from start to finish can be very considerably reduced. This may, therefore, have an important bearing on the solution of the day-baking trouble.

Nitrogen Requirements.

As a result of a request for information as to Australia's nitrogen requirements received from the British Nitrogen Products Committee, inquiries into this matter have been carried out. The objects of the British Committee are to consider the relative advantages for Great Britain and for the Empire of the various methods for the fixation of atmospheric nitrogen from the point of view both of war and of peace purposes.

Chemicals Committee.

A large number of inquiries and investigations has been carried out by the Chemicals Committee, and a considerable number of analyses has been made of raw materials which promise to have an economic value. Valuable service to several important industries has been rendered through the special knowledge and advice of members of this Committee.

If we are to prove ourselves fittest to survive in this great struggle we must walk with science hand in hand. We must seek its aid in order to achieve victory, we must enlist its services in order to prepare to meet the conditions which will arise after the war.

—W. M. HUGHES.

An Engineering Standards Association for Australia.

An account has already been given in this *Journal* of the steps which had been taken by the Institute up to August, 1919, towards introducing a systematic scheme for Engineering Standardization in the Commonwealth, and in the pamphlet which has been published by the Institute on this subject an outline of a scheme of organization for an Australian Engineering Standards Association was given. This proposal has now been considered and approved by a committee appointed by the Council of the New Institution of Engineers of Australia, and as a result agreement has been reached between the Institution of Engineers and the Institute of Science and Industry for the constitution of a Main Committee, the general functions of which will be as follows:—

(*a*) To decide what standardization work shall be undertaken.

(*b*) To appoint the members of the Sectional Committees to which the work of preparing the specifications will be intrusted.

(*c*) To arrange for the carrying out of research work on the recommendation of the Sectional Committees.

(*d*) To receive and pass the reports and specifications of the Sectional Committees.

(*e*) To control finance.

(*f*) To arrange for publication of the specifications.

(*g*) To keep in touch with Engineering Standards Associations in other countries and with the Institute of Science and Industry.

(*h*) To control the secretarial staff of the Association.

It has been decided that a recommendation shall be made that the Main Committee be appointed by the Commonwealth Government, the members to be nominated as follows:—

(*a*) Six members to be nominated by the Institution of Engineers of Australia.

(*b*) One member, who is to be a fully qualified engineer, to be nominated by each of the State Governments.

(*c*) Three members, one of whom shall be Chairman, to be nominated by the Institute of Science and Industry.

(*d*) The Main Committee shall have power either to nominate members to be co-opted on account of their eminence in the engineering profession, or to recommend that other Engineering Associations and Societies in Australia be invited to nominate representatives for appointment.

The question as to the place at which the Standards Association shall have its head-quarters presented some difficulty, but it has been provisionally agreed that the head offices of the Association shall be

established in Sydney, where the new Institution of Engineers of Australia already has its offices at the Royal Society's House. The Institution intends in a few months' time to appoint a fully qualified engineer as permanent Secretary, and it is proposed that this officer shall act also as Secretary to the Standards Association. It has therefore been provisionally agreed that the head-quarters of the Association shall be in Sydney, provided that the Institution of Engineers furnishes the necessary secretarial staff and office accommodation.

Until the new Institution of Engineers has completed its arrangements for carrying on its administrative and executive work, it will not be practicable to establish the Standards Association in Sydney. In the meantime the Institute of Science and Industry is pushing on with arrangements for extending the scope of Australian Engineering Standards. The preparation of the Standard Specifications for (*a*) Structural Steel, sections, (*b*) Railway Rails and Fishplates, and (*c*) Tramway Rails and Fishplates respectively is now practically completed, and the Specifications will be published at an early date. Several requests have been received by the Institute from manufacturers and users to convene Standardization Conferences in regard to various materials, and at the present time the necessary preliminary information is being obtained and data collected with a view to convening conferences to agree as to standard specifications for cement and for certain materials used by carriage, waggon, and motor-body builders.

In taking action for establishing an Australian Engineering Standards Association, the Institute of Science and Industry is giving effect to the principle which it has adopted from the outset in regard to standardization work. The Institute does not in any way desire to carry out this work itself, but it wishes to provide the organization and to otherwise assist the Engineers of Australia to do the work for themselves through their own organizations.

In a recent issue of the *Engineering News Record*, Dr. E. B. Rosa, the eminent physicist of the Bureau of Standards at Washington, pointed out that one of the lessons which the war has taught us is that standardization and simplification of sizes and styles are practicable, and go far in the direction of reducing costs and investment in stock. When one thinks of the immense opportunity for improvement in these respects in purchases by the Federal, State, and Municipal Governments, it is hard to refrain from extravagant language as to the duty of the hour and the obligation resting upon those in authority to act promptly in this matter. It is therefore eminently satisfactory to know that one of the first steps taken by the Council of the new Institution of Engineers of Australia at its first meeting was to affirm the scheme proposed by the Institute of Science and Industry, and to reach an agreement for the constitution of an Australian Engineering Standards Association.

The Prickly Pear.

Enemy Pests to be Tried.

By E. N. ROBINSON.

People in the southern portions of Australia are inclined to treat with contempt and incredulity the oft-told story of the onward march of the prickly pear. Conversely, in Queensland and the north-western areas of New South Wales pastoralists and farmers have ceased to complain about the exactions levied by this, the most ruthless and remorseless of all monopolists. They have become used to its depredations, and they regard its continued encroachment upon occupied land as inevitable and unavoidable. Many pastoralists have already been driven off their holdings. Many others resignedly forecast the day when they will be compelled to evacuate.

The question whether the prickly pear shall remain in undisputed possession of huge areas of country, and shall be allowed to swallow up others, is however one of national and not individual concern. The matter is one which Australia must decide. The pest long ceased to be a local affair, nor can one State claim it as its own particular problem. Huge sums have been spent by Queensland Governments in their attempts to eradicate or check the spread of the plant, and tempting monetary rewards have been offered to private persons as an inducement to employ their knowledge in preparing a means of coping with the evil. The annual answer of the prickly pear to all the thought and labour expended upon its suppression during the last twenty years is a move forward into hitherto clean country, and a strengthening of its defences in newly-occupied areas.

The seriousness of the position to the Commonwealth is shown by the following figures. Three years ago the area infested was estimated by the Lands Departments of Queensland and New South Wales as 22,208,000 acres. Of this area Queensland supplied 20,000,000 acres and New South Wales the remainder. The most disquieting feature, however, is the rapid extension of the pest. It has been estimated that its annual rate of increase is 1,000,000 acres. The Commonwealth cannot fence off over 20,000,000 acres of land, much of it good grazing land, and some of it arable land, and be content to "cut the loss." New boundaries would constantly be required to be erected—north, south, east, and west. The prickly pear might now claim to be Australia's principal primary product. It covers a greater area of country than the combined areas of all our cultivated crops, and would envelop, with plenty to spare, the whole of Tasmania.

One of the first problems which the Institute took into consideration was an investigation of the prickly pear. The means of eradication **which naturally suggested themselves were:—**

- **(*a*) Destruction by mechanical means;**
- **(*b*) Destruction by chemical means;**
- **(*c*) Destruction by utilization; and**
- **(*d*) Destruction by natural enemies.**

It was found that destruction by mechanical means had been freely tried, both by Governments and by individuals, but had proved too expensive for adoption on a large scale, though they are used to some extent in clearing valuable agricultural land. Destruction by chemical means had also been thoroughly investigated. It was found that the arsenious chloride method was the cheapest, but even in this case the price imposed great restrictions upon its employment. Nor has destruction by utilization proved commercially successful. Potash and paper making were two industrial uses to which the pear was to be put. But the pear still grows apace, and supports no industries. The pear cannot be eradicated by feeding it off to stock, and so there remains

Photo. by A. T. Clerk, Lands Dept., Brisbane.

THE PEST PEAR (*Opuntia inermis*), showing dense pear in Brigalow Scrub.

but the fourth line of investigation to be followed, viz., destruction by natural enemies.

A few years ago the Queensland Government appointed a Commission to visit all parts of the world to investigate the natural enemies of the prickly pear. Dr. T. Harvey Johnston, now Professor of Biology of the University of Queensland, and Mr. H. E. Tryon, Government Entomologist, undertook the search, and they were successful in discovering an insect, *Coccus indicus*, which was introduced into Queensland, and has practically exterminated one species of pear, *Opuntia monocantha*, in every district where it was liberated. Unfortunately it will not attack *Opuntia inermis*, which is the pest pear. In view of the partial success due to the importation of *Coccus indicus*, and of a general consideration of the whole question of plant parasitology, the

Institute has prepared a scheme for attacking the problem anew. Recently an agreement was completed whereby the Commonwealth Government agreed to pay £4,000 per annum for a period of five years, and the States of Queensland and New South Wales to each pay £2,000 per annum for a similar period, for research work into the possibility of eradicating the pear. It is proposed that the work will be carried out under the control of a chief investigator who will receive a salary of £1,200 per annum, while a special Committee representing the Governments of Queensland and New South Wales and the Institute will be appointed to control the expenditure of money and the business side of the investigations.

Photo. by A. T. Cle:k, Lands Dept., Brisbane.

THE PEST PEAR (*Opuntia inermis*), showing dense pear in open forest country.

In a bulletin dealing with the prickly pear issued by the Institute, it was pointed out by Mr. W. B. Alexander, M.A., that enemies of plants may be divided into two classes, namely those which live on a great variety of plants, which may be called omnivorous vegetarians, and those which can only live on a particular species of plant or plants of a single natural family, which may be called restricted vegetarians. He states that this distinction should be carefully borne in mind when discussing the possibility of utilizing natural enemies for the destruction of vegetable pests. Owing to the fact that many forms of life introduced into Australia have become widely destructive to a great variety of plants, a strong feeling has grown up adverse to the introduction of any more foreign animals of any kind whatsoever. There is, however, no introduced animal whose destructive habits in Australia

could not have been foreseen if careful inquiries had been made beforehand in the countries from which they were brought. The case of the rabbit is often quoted, and many people in Australia appear to believe that the great destructiveness of this pest in Australia is quite peculiar to this continent. Any one familiar with conditions in England knows, however, that in country affording good cover for rabbits it is necessary to use wire netting to protect crops or young plantations just as is the case in Australia. The larger population, the severer winters, and the presence of natural enemies in the form of stoats and weasels are undoubtedly the main or only reasons why rabbits are not such serious pests in England as in Australia.

The natural enemies of prickly pear, like those of other plants, fall into the two categories already mentioned. Owing to its succulence the prickly pear may in some cases form the principal food of certain omnivorous vegetarians in localities where it is abundant, yet there is no question that if the prickly pears were exterminated these forms would continue to thrive on the native vegetation or cultivated crops, hence their introduction would be quite unjustified.

Amongst these omnivorous vegetarians certain rodents, snails, and insects may be mentioned. In the cactus regions of the United States and Mexico there occur several species of "wood-rats" belonging to the genus *Neotoma*, which at times cause great havoc to prickly pear, utilizing it as food to such an extent sometimes as to exterminate it in some areas. However, since they are not restricted in their dietary to prickly pears their introduction to Australia would involve grave risks, and cannot be recommended.

Mr. W. W. Froggatt has observed that the common snail (*Helix aspersa*) is specially fond of prickly pears in Sydney gardens, and therefore recommended that a very large snail (*Achatina fulica*), from Africa, should be introduced into prickly-pear areas.* This suggestion should be strongly opposed on similar grounds, since the snails are omnivorous vegetarians.

Similarly, numerous vegetarian insects feed largely on prickly pear in America, but are known to feed also on other plants. Included amongst these are the fruit-fly (*Ceratitis capitata*), the mealy bugs (*Pseudococcus obscurus*, and *Rhizococcus multispinosus*), the Cuban cactus-scale (*Palæococcus sp.*), the plant-bug (*Stylopidia picta*), the blossom-injuring beetle (*Trichochrous texanus*), the root-boring beetles (*Cactophagus sp.*), the cactus aphis (*A. gossypii*), and the cactus red-spider (*Tetranychus sp.*). In Australia, also, certain native plant-feeding bugs have been observed sucking the juices of prickly pear, and at times causing damage to the plants thereby. These include the Rutherglen bug (*Nysius venitor*), and the coon bug (*Oxycarenus lenticulosus*). The utilization of any of these cactus enemies for the destruction of prickly pear is too dangerous an experiment to be attempted.

Professor Harvey Johnston recently attended a meeting of the Executive Committee of the Institute, and sketched in general outline the conclusions arrived at by the Queensland Travelling Commission, and indicated generally the work which might be undertaken. He pointed out that there were a number of organisms which attack

* Froggatt, W. W. Insects and Prickly Pear. *Agricultural Gazette of New South Wales*, vol. xxviii., p. 417, 1917.

Cactaceæ. The Commission, he said, had found some which apparently confine themselves to one species of cactus, and when introduced even to closely related species died out. He thought that it might perhaps be possible by breeding a large number of insects to obtain a mutant

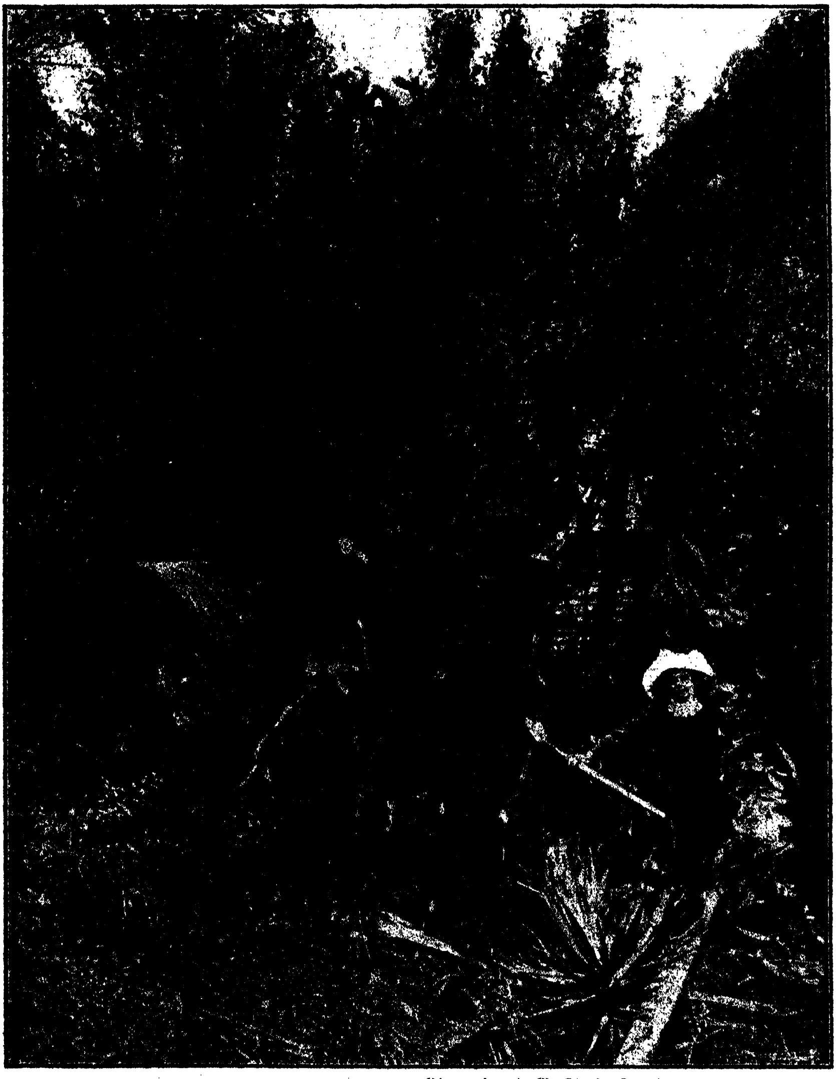


Photo. by A. T. Clerk, Lands Dept., Brisbane.

TREE PEAR (*Opuntia monacantha*), 18 feet high.

which might feed on the pear pest. In order that this might be done pears might also have to be hybridized to induce the insects to transfer their attention. The reason why the *Coccus indicus* has such a baneful effect upon the monocanthus opens up another field of inquiry.

In addition to the *Coccus indicus* there is quite a large number of insects belonging to other families—bugs, flies, moths, and beetles—which are known to prey upon one or other species of prickly pear. Some of them attack by feeding on the pear, and some act apparently by local poisoning. Some exert a detrimental influence by mass action, while others again attack the flowers and prevent the development of fruit. These insects are to be found in parts of America. Professor Johnston expressed the opinion that in Mexico might be found a number of useful insects. Another promising field was Uruguay and other parts of South America. In the Argentine, for instance, there is a moth which preys in the larval stage upon the prickly pear, and

WILD COCHINEAL (*Coccus confusus newsteadi*) on *Nopalea cochinelifera*, Antigua, West Indies. (From Report of the Q'lnd. Prickly Pear Travelling Commission.)

it feeds so ravenously upon the fleshy material of the big joints that the plants cannot repair the waste, and die. Professor Johnston saw instances of such destruction along the foothills of the Andes, but he was too late to catch the insects at work. At Buenos Ayres he found what seemed to him to be a similar agency in operation. These organisms he considered to be well worthy of consideration.

The Travelling Commission also found at least one fungus disease which was capable of seriously retarding new growth. Given certain conditions which would obtain during a moist summer in Australia, it is felt that the fungus would cause heavy loss of growth.

The extreme seriousness of the prickly pear pest to Australia to-day, and the certainty that the area of land thrown out of profitable occupation will continue to greatly increase year by year, has led the Institute to make these arrangements for the fullest investigation of the possibility of checking the spread of the plant by employing parasitic organisms. The Executive does not expect immediate and complete success. It feels, however, that until every possible means of fighting the pest has been thoroughly tested the country should not be handed over to the pear. The facts quoted above, which form only the briefest *résumé* of the principal features embodied in the Travelling Commission's report, suggest the possibility of success. Every precaution will be taken against the introduction of pests harmful to any plant but the variety of prickly pear it is intended to attack. All importations will be made under the strictest safeguards, and breeding operations will be carefully controlled.

Professor R. D. Watt, a member of the executive committee of the Institute, is making a trip to Great Britain and the United States of America. While in London he will represent the Commonwealth at the conference to be held under the auspices of the Imperial Bureau of Entomology. While in the United States of America Professor Watt will investigate, on behalf of the Institute, methods of utilizing prickly pear as food for cattle.

Professor Fawsitt, who is a member of the New South Wales committee of the Institute, and Professor Lawson have obtained leave of absence from the University of Sydney, and will visit Great Britain.

Science in Agriculture.

How Denmark has Prospered.

No. I.

[*The Department of Repatriation, as part of its educational scheme, selected special men of the A.I.F. to study the agricultural methods of certain countries before returning to Australia. This article was written by Captain W. R. Birks, who was in charge of the party which visited Denmark, and it explains the reasons of Denmark's eminence as an agricultural country. It has been kindly made available by the Comptroller of Repatriation.*]

The A.I.F. party of twenty-seven all ranks, after what must have been an exceptionally calm two days' trip across the North Sea, arrived in Copenhagen early on the morning of 18th July.

The first official function of the tour was a formal welcome by the Royal Agricultural Society of Denmark at the society's rooms. Here Mr. H. Faber, Danish Agricultural Commissioner for Great Britain, who was chiefly responsible for the organization of the tour in Denmark, gave a short address of welcome. A supply of literature was also distributed to each member of the party. This included a detailed programme for the whole tour, maps of the country, a guide to Copenhagen, and a publication entitled, *A Short Survey of the Danish Agriculture*, the latter in English. So accustomed have the Danes become, as Mr. Faber explained, to foreigners visiting the country for the purpose of studying its agricultural practices, that it has been found necessary to publish this pamphlet in several languages. Mr. Faber also drew attention to his book, recently published in English, on *Co-operation in Denmark*. Another book which proved of great utility on the tour was Rider Haggard's *Rural Denmark*. Sir Rider himself visited many of the localities and institutions embraced in the itinerary of the A.I.F. party, and with the exception of differences in prices owing to war conditions, his information was always found helpful. With copies of these three publications the party was provided with a good working reference library for the purposes of the tour.

Following Mr. Faber, a paper on the "Dairying Industry of Denmark" was read by Mr. G. Ellbrecht, Dairy Commissioner to the R.A.S.D. This was one of five papers specially prepared for the information of this party, and arangements had been made for the distribution of a typed copy to each member. A striking feature of this address was the comparatively recent development of the industry, that is to say that it has increased from insignificance fifty years ago to its present dominating position in the country's agriculture. Accompanying this increase in dairying there has been not only a total disappearance of the export of grain, but a very considerable import of grains and concentrates has sprung up, while the area sown to grains of all kinds has actually increased, and the area sown to roots and other

fodders has increased enormously. This general tendency to change over from the production of crop products for export to their conversion into animal products before removal from the farm, has a special significance for Australian farmers, and it was remarked that along with other improvements in the general farming of the country (*e.g.*, increase of production per head of stock, adoption of more prolific varieties of all field crops, and the growth of co-operative enterprise), although simmering, as it were, throughout the latter half of last century, by far the greater part of all this agricultural reformation has been accomplished within the last twenty years.

The second day was spent in visiting the warehouse of the Co-operative Wholesale Society and the Co-operative Egg Export Depôt. At the former institution, housed in a fine modern building, Mr. Hans Jorgensen addressed the party, and incidentally, in his opening remarks of welcome, thanked them for their part in bringing about the restitution of South Jutland, which is everywhere taken as a foregone conclusion, at least as far as concerns the country lying north of the town of Sleswig.

Mr. Jorgensen, himself a plant-breeder at one time, is now in charge of the seed department of the society, and before conducting the party over the warehouse, gave a short address on the position of co-operation in Denmark generally. He spoke of the early philanthropic efforts of his father, who was a comparatively wealthy man, in founding the society, and financing it in its early stages; of the difficulties met with in public apathy, and the positive opposition of "the interests," and even of the Government; and finally of the rapid development of the society, since 1898, to its present commanding position. The annual turnover is now £4,000,000, and the affiliated (retailing) societies numbered twenty years ago 300 as against 1,600 to-day. (The population of Denmark, by the way, is about half that of Australia.) The position now is that if the society cannot obtain any particular "line" at a reasonable figure it establishes the necessary factory for its production, and thus has a big influence in protecting the public generally against overcharging. As illustrating the growth of co-operative business throughout the country a long list of other enterprises was quoted, from which the following are selected:—Societies for the export of cattle, manufacture of cement, import of coal from England, and the great Workers' Bank. Mention was also made of the possible early union of co-operative societies throughout Scandinavia and the other Baltic countries (except Prussia!) into one powerful commercial body.

In connexion with the seed supply of the C.W.S., it was pointed out that the society does not actually do any cultivation in bulk. "Elite" samples of the best varieties are supplied to approved farmers who raise, first, "stock" seed, and then the bulk supply (for distribution and sale) under a strict system of contract and supervision, with precautions against hybridizing, &c.

The society has its own seed control laboratory for analyzing and testing the germinating capacity of all the seeds it handles, and through this laboratory the party were conducted. Next, part of the seed warehouse was inspected. Several floors of a large building were seen filled

with the ingenious machinery characteristic of such establishments. As each fresh weed seed or other impurity makes its appearance a fresh machine or an improvement in the old machinery is introduced to effect its removal.

Among the numerous elaborate precautions against mixing of varieties it was pointed out that each variety of seed is handled by the same assistant throughout its various cleaning and packing processes; and that the farmers' individual orders are sent in by the retail societies, and are made up and sealed before leaving the C.W.S. warehouse.

The Egg Export Society's Depôt (visited in the afternoon) appeared rather small for the turnover it handles (a busy day's output is from forty to sixty cases, containing 960 or 1,440 eggs each). The produce is, however, handled very quickly, and only remains in the depôt until shipping to England is available, usually not more than 48 hours at most. The staff apparently consisted of three or four men and as many girls. The eggs are received, from affiliated "circles," in boxes containing 1,000 with cardboard packing. They are graded by hand into five grades (18 to 14 lbs. respectively per 120), but not by colour. They are then tested first for weight, and then over an electric lamp in trays containing ninety-six. None but sound, fresh eggs survive this test. Each egg is then hall-marked with the society's rubber stamp and packed in wood, wool, and straw in the export boxes above referred to. Each case carries the society's brand, and the weight per 120 of the eggs it contains is also stencilled on the outside. As each egg on arrival at the depôt is numbered first as to its circle, and also its farm of origin, for every defective egg the responsible farmer can at once be traced. A warning is issued on the first offence, a 5s. fine for the second, a 10s. fine for the next, and after that expulsion from the circle; but there seemed to be no record of either of the last two penalties being inflicted.

To sum up, the general impression of this day's experience was one of an atmosphere of healthy honesty in ordinary trade, of devotion to work and business for objects other than personal gain, and above all, efficiency.

The morning of the next working day, Monday, 21st July, was spent at the laboratories of the Danish State Seed Control, a famous institution which quite fulfils the highest expectations. The institution is housed in a three-storied building (which, it was pointed out, it has already outgrown) situated in the grounds of the Royal Veterinary and Agricultural College. Like many other establishments visited, this was found to be its "off season," and most of the staff were away on vacation.

The two main departments (seed analysis and germination testing laboratories) seemed to be under the supervision of very capable and enthusiastic lady assistants.

Among other points of interest in the former, the diaphanoscope was seen in use, and in the latter the evolution of the modern electro-thermostat for the germinating tanks was explained; in these there is capacity for making about 3,000 separate tests simultaneously.

It was of interest to learn how eagerly the leading seedsmen study the requirements and standards set by the Seed Control, and the facts

that all seed sold requires by law to be accompanied by a copy of its analysis, and further that all analyses made are published with vendors' names, readily account for the wonderful improvement in the quality of Danish commercial seeds in recent years.

At the college the third official "paper" dealing with plant pathological work in Denmark was read by Professor Ravn, whose special sphere this subject is. The special point brought out in the ensuing discussion was that, with the exception of Barberry, the eradication of noxious weeds and suppression of disease in plants is not enforced by law. The initiative of the individual farmers and their societies accomplishes all that is necessary, and against any negligent or "dirty" farmer is brought to bear a very strong public opinion, fostered by the educational influences of experiment stations, winter farm schools, and private experimenting. Professor Ravn also mentioned the State Seed Control and Co-operative Wholesale Society among the chief influences working for the improvement not only of commercial seeds but of the quality of varieties of farm crops and their resistance to disease.

On Tuesday, 22nd, was commenced a three weeks' tour of the islands and strip of mainland (Jutland) which constitute this country.

At Haslev, a typical farming centre, there were to be seen first the Trifolium Company's principal dairy, a co-operative bacon factory and boiling-down works, a co-operative egg export depôt, and the Haslev Agricultural School. In the dairy (handling gallons of milk a day), and the bacon factory, with a capacity for dealing with 100 pigs a day, there were only minor points of interest to those acquainted with these industries in our coastal districts at home. Both factories, of course, are well equipped and very efficiently conducted, and are types with which one grows very familiar in travelling about Denmark. It was noticed that in the matter of cleanliness the climate here evidently allows greater latitude than do our own high summer temperatures.

In the cheese room an 80 per cent. skim milk cheese with caraway seed flavouring was being turned out with five vats as fast as the milk came from the separators. The cellars had storage capacity for 60,000 cheeses, but very few of the rooms were filled—another effect of war-time prices. In an adjoining room the whey was being evaporated and converted into a sweetish product known as Norwegian cheese, which here was apparently sold without ripening.

The egg export depôt was a miniature of the Copenhagen establishment, with the exception of grading by weight; only very abnormal sizes were culled for local sale along with the "cracked." Finally the Haslev Agricultural School, though of great interest at the time, may be despatched in a few words. It is one of seventeen such schools scattered throughout the country, and better examples of this excellent type of institution were to be visited later. Suffice it to say here that the school is owned and controlled by a philanthropically disposed company of local people (and it must be borne in mind that Haslev is a town of some 2,000 or 3,000 inhabitants only).

The party was conducted over the buildings (which were undergoing repairs) and the 100-acre farm by the principal, evidently a keen and devoted man, who gave a short address. This was the first such occasion, by the way, in which the interpreter's services were required.

As illustrating the amount of plant breeding and crop improvement going on all over the country the experiences of the two following days were typical. Working from Noestved as temporary base an excursion was first made to the seed-growing and cleaning establishment of E. Frederiksen Limited at Klarskov. Here at a railway siding is a fine four-storey factory where the firm's seed is dried, cleaned, and packed for disposal. The machinery again rather baffles description, but may be roughly classed in four groups, namely, the carrot seed equipment with a strong set of brushes working in wire net concave to remove the "bristles" peculiar to this seed; the "hard round" seed set dealing with clover, lucerne, and brassica—types of seed; a set for light grass seeds; and finally ordinary cereal cleaning equipment. The main principle in the latter, which also occurs in almost every other type of cleaning machine, is the revolving pitted drum, so familiar to stud wheat breeders at home.

On the farm belonging to the firm 30 acres are devoted to special breeding, selection, and test work. New types of all farm crops are constantly being worked up by all the principal seed merchants, of whom it was gathered there are about a dozen in Denmark. And tests are made not only of all parcels coming into the firm's hands for re-disposal, but of each lot which is made up for sale. Not content with the State Control's certificate of purity, &c., it is the custom with these wholesale firms to grow a check plot of every parcel of seed leaving their factory. These plots cover large areas, and customers are encouraged to inspect them. They also stand for reference purposes in cases of complaint, and should the test plot indicate a defect in the quality of the seed (a very rare occurrence!) the buyer immediately has a case for compensation. The compensation, in the case of the Co-operative Wholesale Society at least, is very liberal, and promptly paid.

From the remainder of the firm's land—70 acres—bulk seed is raised; in addition, bulk seed is procured from farmers under contract; for example, the firm supplies the seed, the farmer undertakes to grow for and supply to this firm and no other, and to submit to the firm's "control." The latter provides among other things that crops subject to cross fertilization be grown in isolation, and that the most thorough methods of farming be employed, and the firm's inspectors visit the "contract farms" at least two or three times during the growing season. Twenty per cent. of the product after harvest goes to the firm, who also have first option over the remainder of the seed at a price set out in the contract. There are variations from this arrangement, but the above is typical of the method of raising a very large quantity of high-class seed throughout the country. One firm was met with later who numbered among its "contract farmers" some 2,500 growers, and that the seed industry is an important one here was evident from the time the train left behind the suburbs of Copenhagen. Almost every farm carried a few acres at least of carrot, mangel-wurzel, turnip, cocksfoot, English rye or timothy grass, running up to seed—another example of the general tendency of Danish farming towards a decrease of the bulk and a corresponding increase in the value of the product removed from the farm.

To return to Frederiksen's. Lunch was provided at the village inn, and incidentally copies of the firm's catalogue, in English, were

distributed. Later, the party were driven to the Countess Oxholme's estate (a farm of 3,500 acres approximately) for tea and a short tour about the steading.

There still remain in Denmark a number of these large farms on which the organization and working resemble that of a factory.

Among other things of colossal dimensions one of the cow byres was seen with 250 cows chained ready for the evening milking, a sight which became more familiar during the following week.

Another trip made from Noestved was to the State Experimental Farm at Tystofte. Here the paper by the director, Mr. E. Lindhard, on Plant Culture in Denmark was taken as read. There was no time to spare if the farm was to be properly inspected. Mr. Lindhard speaks excellent English, and is a plant breeder of reputation; many of the cereal varieties met with later on the farms bear this station's name. He led off immediately through the experiment fields, and kept up a running series of lecturettes for a couple of hours. There were the usual tests—manurial and variety; permanent and temporary pasture mixtures; then competitive trials of mangels and other roots—varieties actually on the market.

In wheat there was a complex piece of work in progress dealing with investigation into the inheritance of head characters. This originated from a spelt-type sport in a square-head variety some years ago. The number of plots is now 60,000, and there are to be seen wheats of every imaginable type.

One ray of clearness in all this complexity appeared in the square-head types, which had evolved, and were breeding true for the most part; all other types were still splitting up in all directions. Of the cross-breeding and selection work in progress only a list of the types of plants being dealt with can be given. Besides the cereals there were mangels, swedes and turnips, clovers, grasses, and lucernes. Finally Mr. Lindhard explained his most recent venture in tobacco growing and curing. Here is surely a handful of work for one man, and his only scientific assistants as far as could be gathered were a few post-graduate students from Copenhagen and other universities working here for one summer at a time.

At this stage some idea of the general methods of Danish farming was beginning to be formed, and many details which at first never failed to excite remark soon became familiar. Crops of wheat, oats, barley, and peas showing prospects of returns far beyond the range of Australian experience. The growers' estimates ranged from 60 to 80 bushels per acre, and of mangels at times 40 tons.

More striking still at first is the very thorough use to which all land is put, and in this respect Denmark can be compared only to the Channel Islands. Little ground is devoted to pleasure purposes, and practically none at all to grazing pure and simple. The parks of the great estates produce timber, and the railway embankments lucerne. All odd pieces of ground are planted with something, and sheep and goats are tethered so that they can eat off the grass growing along the road side. Grazing in this way is almost universal; in the one field there are generally to be seen cattle, horses, and sheep tethered in line to

eat off a crop of mixed grains or grasses, while a fresh and vigorous growth shows up where they had been a few days previously.

The introduction of root crops has done away with the old bare fallow at one time practised, and a general seven or eight course rotation is used. With minor variations in different localities the following may be taken as typical:—(1) Wheat or rye (winter sown), (2) roots (mangels, turnips, potatoes, or sugar beet), (3) barley, (4) roots or mixed grains (oats, barley, peas, and vetches) for feeding off. (5) oats, (6) barley or oats sown with grass and clover mixture, (7) clover and grass for hay and grazing, (8) ditto fallowed during the summer for winter grain again. Of the series of possible diseases this system is arranged to combat, some are quite unknown at home.

Besides the main eight fields on every farm there are generally a few odd paddocks for such purposes as special trials, or seed growing, and a patch of lucerne is by no means uncommon. The latter will stand as a rule for eight years, and yield up to 4 tons of hay per annum in 2 or 3 cuts.

Only a passing reference can be made to the general air of prosperity about the country districts: the substantial and handy buildings, the thorough cleanliness of the steadings and farms generally (a contrast to Picardy), and the very general use of electricity. In localities remote from the larger distributing centres, frequently an extra large windmill on the outskirts of a village was found to be running a dynamo. There was always an oil or suction gas engine in reserve, and of course storage batteries, and it was gathered that these plants usually serve a district of several miles' radius. Where a few steadings are situated close together there is generally to be seen a transformer on poles at the cross roads and power lines running in all directions.

Before leaving Noestved it may be mentioned that opposite the hotel where the party stayed there was a row of fine buildings housing respectively a museum, a technical college, and a "realskole," whatever that sort may be. Lower down the street stood the "Kommune" School; not far from the town there was a boys' college, described as the "Eton of Denmark," and on departure the train passed another agricultural school similar to Kaslev. There may have been others, but these forced themselves on one's notice; and Noestved may be ranked, in regard to population and importance, with Goulburn in New South Wales.

At Maribo was seen one of the eight sugar beet factories of Denmark. This place has a capacity for dealing with about 1,500 tons of beets daily during the season, which opens in a couple of months' time. It was explained that in pre-war days the farmers grew the beets under a ten years' contract, and delivered for about 22s. 6d. a ton. In addition the solid refuse material is returned to the growers *pro ratâ*, for use as cattle feed (its value is 10s. a ton), and 50 per cent. of total profits were distributed among the growers apart from what they might receive as shareholders. Last year, however, the general prosperity of the farmers enabled them to demand 55s. a ton on a one-year contract only, and without the more or less problematical share in the profits. The processes of cleaning, cutting, boiling, pressing, clarifying, and evaporating the syrup to a large grained brown sugar were explained,

though the machinery was none of it in use of course. Another useful product the farmer receives is the lime sediment after clarifying. This is a valuable manure, and is sold to growers at 1s. 2d. a ton in a half-dried state. The company use the rich dirt obtained from washing the beets for reclaiming swamp or fertilizing sandy soil, and finally the farmer uses the beet tops either as green feed or ensiled, layer for layer, with the beet refuse returned from the factory. The final result of this dovetailed system is a very prosperous looking district. Much of the labour for the rush season is provided by bringing across numbers of Polish girls who live in barrack-like buildings on the larger estates. Some of these girls were seen at work on ordinary farm labour on the Sugar Company's model farm. The firm has 45 miles of light railway track, and the party were taken in a couple of trucks for a run through the district which grows the beets, detraining at Mr. Suhr's magnificent property "Scholt." Mr. Suhr is spending, at a very rough guess, about a quarter of a million sterling in establishing a 1,200-acre farm, of which some 300 or 400 acres are timber land.

In reply to the natural and apparently usual question: Is it going to pay? Mr. Suhr explained that he had made plenty of money in the city, and farming was his hobby. This apparently indicates the general point of view of many of the larger Danish land-holders. The steading buildings of this farm are of course palatial, but are designed in such good architectural style as not to seem out of proportion. The main hall of the barn measures, roughly, 500 feet by 100 feet. Into this space loaded waggons can be driven through several doors, and there is an electric hoist arrangement for taking the load off bodily and depositing it in any part of the barn. The cow byres opening from one side of the barn accommodate about 240 milkers, and among other adjuncts there is a small laboratory in one corner for the use of the control officer on his (or her) periodical visits to test each cow's milk and make up the records. On either side of the byres lie the stables and piggery respectively, each of similar dimensions; and over each of these three wings of the steading there is a loft used as fodder store for the animals beneath, and separated from them by a fireproof layer of reinforced concrete. The power-house is a separate building roofed with copper; so also are the men's and girls' quarters, manager's residence, &c. In a central position is a small artificial lake through which all machines and horses will be driven on returning from work and before entering the sheds and stables. So much for an ideal farm!

Personal.

MR. G. D. DELPRAT, C.B.E.

One of the most notable advances in Australian industry of recent years has been the establishment of the Broken Hill Proprietary Limited's iron and steel works at Newcastle. A few years ago a proposal for an enterprise of such magnitude would have been ridiculed. "Australia is not ripe for such a scheme" would have been the objection. The Broken Hill Proprietary, however, held other views, and also the courage of its convictions. It risked about £4,000,000 of its capital upon the venture, and now, after being in existence only four or five years, is providing employment for approximately 6,000 men. More than 4,000 men are at work at Newcastle.

The impetus which this new development has given to industry already has been widely felt. The extent of the influence which it will ultimately exert cannot yet be measured. Apart altogether from exercising a reduction upon the quantities of iron and steel imported into the Commonwealth, it has given birth to new industries whose raw material is the product of the Newcastle works. New avenues for the profitable employment of labour have therefore been opened up, and the district of Newcastle not only feels, but displays in the large and rapid expansion of its surburban areas, the beneficial effect of this huge undertaking.

Mr. G. D. Delprat, whose portrait appears in this issue, is the general manager of the Broken Hill Proprietary Limited. To his enterprise was largely due the extension of the corporation's activities. His long connexion with the Broken Hill Proprietary, and the fact that he has been closely associated with the many successful and important innovations which have marked the progress of the company's operations, have caused his name to be widely known. He joined the Broken Hill Proprietary in 1898, and a few years later (in 1903) had discovered and patented a process of flotation without the use of oil. This process is now almost universally adopted. Having a large stock of bisulphate of soda on hand, Mr. Delprat instructed the company's research chemist to make certain investigations, and it was soon found that on placing some of the tailings in a strong solution of this salt and heating it in a beaker that the sulphides were floated as a high-grade concentrate, leaving the gangue in the bottom of the beaker. Then followed the erection of an experimental plant, and the results were so successful that patents were applied for in November, 1902.

Considerable difficulty was at first experienced in placing this new process on a commercial footing. First, one type of separation vessel was tried, then another. At least a dozen attempts were made before a suitable design was made. In May, 1903, 50 tons of zinc concentrates had been produced by the new process from zinc tailings which were ordinarily dumped. This parcel was the first zinc concentrate ever produced by flotation. By October, 1904, 500 tons of tailings were being treated, and up to the present time no less than 902,172 tons of zinc concentrates have been produced.

For the first four years the "Delprat" process was the subject of considerable litigation, the cause of which was a prior patent taken out by the late Mr. C. V. Potter in November, 1901, for obtaining the same results by the use of dilute acid solutions. The contention that Potter's patent was invalid was upheld by the Courts through which it passed, but prior to coming before the High Court an agreement was made between the parties by which the Broken Hill Proprietary obtained the free use of either the "Delprat" or the "Potter" patents. From this time onwards, owing to sulphuric acid being substituted for bisulphate of soda, the process became known as the "Delprat-Potter" process, and the litigation ceased.

Before coming to Australia Mr. Delprat occupied many important positions in the mining industry in other parts of the world. The story of his success is in all essentials the story of most successful men. It is summed up in hard working and hard thinking. His inclination was always towards science. Born in Delft (Holland) in 1856, he finished his education at the local high school, and went to Scotland to serve his apprenticeship as a constructional engineer. His evenings were given to study. During his spare hours he attended lectures in chemistry and physics at St. Andrew's University, and he further pursued these studies at the Amsterdam University. For a period he worked under the eminent physicist, Professor Waals. His first important position was as chief metallurgist for the Thasis Sulphate of Copper Company in Spain, and after four years in that capacity was placed in charge of the mines and works.

Two years later, in 1885, Mr. Delprat joined the Bede Metal and Chemical Company as manager of several mines, and in 1888 the general management of the whole business was placed in his hands. This company is a corporation formed by some of the directors of Armstrong, Whitworth and Company, including Sir Andrew Noble, Sir Mark Palmer (shipbuilder), Sir Walter Scott (contractor), and Mr. James Hall (ship-owner). The syndicate owned and operated many large mining properties, and in the inspection of properties Mr. Delprat journeyed all over the world. It was the policy of the syndicate to operate any new mine taken up as a separate company, retaining the same directorate, and Mr. Delprat was appointed managing director of them all. He remained with the Bede Metal and Chemical Company until, in 1898, he accepted the position of general manager of the Broken Hill Proprietary Company Limited.

The vast experience which Mr. Delprat had gained has been put to good effect in the administration of the affairs of the Australian Proprietary. His big triumphs have been, as already indicated, the discovery of the flotation process and the establishment of the iron and steel works. The full fruits of the latter enterprise have not yet been gathered, but the tree is making vigorous growth.

Mr. Delprat was one of the original members of the executive committee of the Institute of Science and Industry, and during the vicissitudes of the past four years has not allowed his enthusiasm for this new Commonwealth undertaking to weaken. Recently upon his return from a visit to the United States and Great Britain he expressed his disappointment that the Institute had not yet been placed on a permanent

basis. "Australian industry," he stated, "wants all the assistance that science can give to it. Australia has got a splendid chance, but she cannot afford to ignore the example set by other countries. The war awakened Great Britain to the value of science. America realized it before the war, but in many directions, now that peace has been restored, that country is increasing her subsidy to science."

PROFESSOR CLELAND.

Dr. John B. Cleland, who for the past seven years has been in charge of the microbiological work connected with the Health Department of New South Wales, has been appointed Professor of Pathology—a newly-created chair—at the University of Adelaide.

As an original investigator Professor Cleland's name is well known in scientific circles. He has largely devoted his time to the preparation of prophylactic vaccines, the recognition of doubtful microbes, and the microscopic investigation of unknown diseases. Outstanding work has been performed by him in the etiology and the mode of transmission of dengue fever. He has also carried out investigations into the transmission of the mild form of small-pox present in New South Wales some years ago to calves and to monkeys, and recently had an opportunity of investigating the nature of "X disease" (an unusual form of encephalitis in man, allied to infantile paralysis), and successfully conveying this to monkeys, the sheep, the calf, and the horse, and thus opening up an avenue along which possibly control of the disease may be obtained. Other work that has occupied his attention is inquiry into a form of endemic hæmaturia in cattle, contagious mastitis in cows, black disease in sheep, and other animal diseases.

As recreation Professor Cleland has pursued the study of ornithology and botany. In regard to the former he has done a large amount of field work, and has studied certain parasites of birds as well as the economic aspect of bird life. In the latter he has paid particular attention to the higher fungi. He looks forward in his new sphere to following up various lines of research upon which he has been engaged, and to completing his work on influenza.

Professor Cleland is a son of the late Dr. W. L. Cleland, is forty-one years of age, and is a native of the city to which his new appointment takes him. After three years' study of medicine at the University of Adelaide he completed his course at Sydney, where in each of the two years he was second in the list of honours. After graduating Dr. Cleland filled a number of local medical appointments, and in 1903 he went to England, where he was engaged in medical work for a couple of years. In 1904-5 he was Cancer Research scholar at the London Hospital. Upon returning to Australia he was appointed pathologist and bacteriologist to the Western Australian Government, and then, going across to Sydney, he engaged in microbiological work for the Health Department. Dr. Cleland was a member of the special committee on worm nodules in cattle, and of the special committee on the electrical sterilization of milk appointed by the Institute of Science and Industry.

REVIEWS.

EDIBLE FATS AND OILS, C. Ainsworth Mitchell, B.A., F.I.C., pp. xii + 159. Longmans, Green, & Co., 1918, London. 6s. 6d. This book belongs to the series of Monographs on Industrial Chemistry, edited by Sir Edward Thorpe; by which it is hoped to afford examples of the application of recent knowledge to modern manufacturing procedure. Such books are not intended to cover the whole ground of the technology of the subject. We have the fine work of Lewkowitsch for that purpose. Thorpe's series are not concerned so much with the minute details of manufacture, so that Mitchell's book deals with the chemistry and characteristics of the oils that can be made edible, and he endeavours to give a description of the methods of extracting such oils and fats from the crude material and of purifying and preparing them for food purposes. To render the book a convenient source of reference, foot-notes and an extensive bibliography (pp. 124-151) are given, in which both the original reference and the abstract in the English or other journals are given, and they are arranged according to the subject headings of the various chapters

The first two chapters cover the nature and properties, composition and constituents of oils and fats (pp. 1-23), and is a good and up-to-date account of the subject. An interesting section deals with the rancidity of fats, a subject in which both the butter-maker and the margarine manufacturer are vitally concerned. Chapter IV. gives a good summary of the methods of examination (pp. 35-56). We would like to see some indication, with so many tests, which are the most reliable ones for the various oils, *e.g.*, Laucks places the iodine value first in his examination of commercial oils. Chapter III. covers rather too briefly the extraction and purification. Here we find the few illustrations of machinery used. The section on Purification (bleaching, deodorizing, and removal of rancidity) is too condensed, as it is in this part of the work that the main problems occur in the commercial preparation of an edible food from the raw material. The body of the text gives the details of the individual oils (pp. 57-106). This includes tables of typical values to enable one to ascertain the standards of purity. The last two chapters deal with Hardened Oils and Manufacture of Margarine. While the latter gives some of the more modern types of machinery for the processes of manufacture, the two chapters do not appear to be quite as up-to-date as one would expect in such a monograph. Such information should have been brought almost to the date of publication. In hydrogenation there does not appear to be anything later than 1913, and that in a subject which was advancing so rapidly (see Hydrogenation of Oils, by Ellis). The margarine section comes to 1914. There are several references to the presence of nickel in hardened oils, but recent English preparations (before 1918) did not contain appreciable quantities as stated.

Information is given on aroma production by bacterial cultures, and attempts at producing browning properties in imitation of butter; but nothing is mentioned about the presence of vitamines in margarine. This was one point on which the supporters of butter as a food relied when they stated that it contained some natural property which rendered it more suitable and more digestible than margarine. Such statements were recently made in Melbourne before the Board of Trade, but all recent investigations in America and Europe place properly-manufactured margarine—which does contain vitamines—a point or two ahead of butter in digestibility, and it is much purer and more easily handled since fats have been hydrogenated. Food rations, butter tickets, and well-made margarine have broken down the English prejudice against margarine; and Australian

butter, if not of the best quality, will have a still greater competitor in margarine than it has had in the past. The book should find readers in all persons having any connexion with such foods as well as in the technical workers in fats and oils.

COMMERCIAL OILS, VEGETABLE AND ANIMAL. J. F. Laucks, B.S., M.S. pp. viii + 138. John Wiley & Sons, New York, 1919. This book is intended primarily for the man in the oil trade, consequently much of the information refers to trade rules, specifications, and maximum and minimum values of the so-called constants to show what can reasonably be expected in commercial practice. As many Oriental oils are being imported into the Pacific coast ports of the United States of America, their characteristics are given separately, as they so often vary from the general standard of oils from other parts. In some cases this is due to climatic and soil conditions, and in others to the treatment, to carelessness, or to unavoidable commercial conditions. These differences have often led to buyers rejecting Oriental oils. We have had a similar case recently of sandalwood oil from West Australia. This cannot be made to conform to the B.P. standard for *Santalum album* oil. Laucks recommends that new standards should be drawn for these Eastern and similar oils.

The book contains but four chapters. Chapter I (pp. 1-29) gives a very useful and handy account of the general properties (physical, chemical), classification, preparation from raw material and examination. All useless tests are discarded and the special value of any particular test retained is clearly indicated, *e.g.* Saponification No., the Iodine No., and the Refractive Index. Not much reliance is placed on Reichert-Meissl No. and the Acetyl Value owing to these values increasing with the age of the oil. In examining castor oil, however, the acetyl value is especially important, and similarly the Reichert-Meissl No. is of importance in butter fat and coconut, porpoise, croton and maize oils. A specimen examination (pp. 26-29) clearly indicates the general method.

Chapter II (pp. 30-100) gives the detailed information on the individual oils which follow the classification of Lewkowitsch, and hence includes solid and liquid waxes.

The remaining two chapters deal with the uses of oils and sampling. There are given the oils used in making margarine, varnishes and paints, lubricants, soaps and candles, polishes, and the various substitutes, *e.g.* rubber and butter. A tabulated account is given as an appendix of many less common oils.

The hydrogenation of oils is dismissed in less than a page. This is a pity when we consider what great changes have been brought about in the commercial handling of oils that have been hardened.

The book is well printed, and forms a well condensed and convenient reference book.

CATALYTIC HYDROGENATION AND REDUCTION. Edward B. Maxted, Ph.D., B.Sc., F.C.S. pp. viii + 104, with 12 illustrations. London, 1919. J. & A. Churchill. 4s. 6d. This is a small book of the series of *Text Books of Chemical Research and Engineering* edited by W. P. Dreaper, F.I.C. It is written with the object of presenting in an easily accessible form the numerous examples of catalytic hydrogenation which have been published from time to time in much scattered literature. Special attention is given to experimental methods. The first three chapters (pp. 1-27) are introductory and deal with the preparation of catalysts, *e.g.* the Nickel group (Ni, Fe, Co and Cu) and the Platinum group and colloidal condition, and the principal methods of catalytic hydrogenation. The next two chapters cover the hydrogenation of unsaturated chains and rings, the sixth chapter on miscellaneous reductions, and the seventh on the reverse reaction of dehydrogenation, chiefly by copper and palladium. References to all the original papers are given, and though a small book the matter is printed in large clear type, and the numerous organic formulæ are very well done.

The closing chapter (82-101) gives an account of the technical hydrogenation of unsaturated oils, the preparation and efficient plant for production of a catalyst on a large scale, the commercial preparation of pure hydrogen, and the determination of the Iodine value, Refractive Index and the detection of Ni. Diagrams are given for plant for converting oils into solid forms, and details of temperatures, pressures and periods, &c., are given. A name and a subject index are added. Though small, the book is packed with details of sound, practical information, which is quite up to date.

Photo. by Ruth Hollick.

Mr. A. E. V. RICHARDSON, M.A., B.Sc., Agricultural Superintendent, Department of Agriculture, Victoria, and Member of Executive Committee of the Institute of Science and Industry.

(For Biographical Notes, see page 121.)

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

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Our Forest Products.

THERE are so many directions in which production can be stimulated along sound and enduring lines in Australia that apparently the country stands bewildered and helpless as it surveys the field. But a beginning has to be made somewhere and at some time. A number of strong reasons exist why, as an initial step, serious consideration should be given to the commercial exploitation upon a scientific basis of our forest wealth. Several of the States, although late in the day, have come to realize the vital necessity of a forest policy. The saving of the remnants of our magnificent timbered areas could no longer be safely left to posterity. Present needs compelled the careful husbanding of diminished resources, and some provision for the near future. Hand-in-hand with the prudent management of the forests should go the economic utilization of the products of those forests. On all sides there is talk of " Key " industries, " The development of the country's natural resources," and " Post-war reconstruction." All these purposes can be helped by backing up State endeavour and determining the best uses to which the flora of Australia can be most appropriately put.

None of the States possesses an institution sufficiently well equipped for the investigation of the various problems which suggest themselves. And for each State to attempt to undertake the work on its own account would obviously result in overlapping and unnecessary waste of money, as well as of the abilities of the scientific men actually engaged in research. Hard as the times may be through which Australia is now passing, nevertheless she can better afford to be liberal with her cash than wasteful of her trained scientists. No doubt the States themselves would welcome an opportunity for co-operative and co-ordinated effort, and those States with big forest areas have already intimated a strong desire for economic exploration along one or two main channels rather than for isolated and detached experimentation.

Many of the problems of the States are practically identical. The vegetation of Australia is highly peculiar. A great number of grasses, and the most widely distributed plants native to Australia, are quite different from those of other countries. Many whole groups of plants, such as the genus Eucalyptus, are entirely Australian. The effect of this high degree of peculiarity in one flora renders it essential that, for the full development of our forest and vegetable resources, researches into the products of our indigenous plants should be conducted.

Australia to-day, in addition to being a manufacturer on a fairly large scale of leather products, is an exporter of leather. At the same time, she is an importer of tannin. The position is incongruous. No exhaustive survey has been made of the indigenous tannin-producing flora; nor has the possibility of manufacturing paper pulp been inquired into. For some occult reason, Australia is believed by her own people to be incapable of producing paper pulp, or even of growing timbers which will yield the necessary fibre. From the incomplete, superficial experiments that have been made, however, there is reason to assume that paper pulp can be economically made from some of our Eucalypts.

Information gained from investigations as to the distillation products of Australian timbers, from laboratory tests made at the Forest Products Laboratory, Wisconsin, U.S.A., with bluegum (*Eucalyptus globulus*) grown in California showed that it compared very favorably with the standard American species—beech, birch, and maple—in the yield of wood alcohol, acetate of lime, charcoal, and tar. The consulting engineer in charge of that institution considers that timber grown in Australia should give even higher yields owing to its slower growth, and consequently its denser nature. But of these facts Australia knows nothing, and apparently cares nothing. A complete investigation under this heading is vital for defence purposes alone, unless, of course, Australia enjoys by Divine dispensation eternal immunity from attack. Aeroplane and land transport depend upon liquid fuel, and Australia in

turn now depends upon outside sources for her supplies. As an insurance measure, it would not be amiss if this country knew everything that there is to know about the most economic available local sources of supply.

Regarding the every-day use of our timbers, practically nothing is known of their special suitability for special purposes. No comprehensive physical tests have been made of them, no honest effort has been put forward to ascertain the best methods of preservation against the attacks of insect and fungoid pests, and no conclusive information has been gained as to the best methods of seasoning. Yet definite information upon each one of these points would prove of the greatest value to every trade which uses timber, and would greatly enhance its value as an exportable article. A striking commentary upon our methods is the statement, quoted elsewhere in this issue, of a leading American commercial man. America would probably import great quantities of timber if something were known of its varying qualities. Nothing of a helpful character is known, so consequently there is no business.

A forest policy without a forest products laboratory is a half-finished job. Facts of the highest economic importance would be gained after several years of investigation, and some of them might exercise an important and direct bearing upon the afforestation or re-afforestation policy of the future. There are large areas of our third-class country which, so far as can be judged at present, will never be profitably devoted to agriculture. It is not merely conceivable—it is highly probable—that they might even now be profitably devoted to sylviculture. A preliminary step taken by every individual who produces anything from the land is to ascertain what kind of crop it will pay him best to grow. A forest products laboratory should go far towards settling this point for the various States, and for the country as a whole. It might even be the means of establishing small plantations, owned and worked by the private individual. If for no other reason than to solve the mystery, and so rescue Australia from the humiliating position of being unable to furnish an answer of how Germany used the grass-tree gum which she imported, such an institution might alone be justified.

—E. N. R.

EDITORIAL

FOREST PRODUCTS LABORATORY.

In this issue there appears an article by Mr. I. H. Boas on Forest Products Laboratories in other parts of the world. Mr. Boas has recently returned from a trip round the world, where, on behalf of the Institute of Science and Industry and the Western Australian Government, he has been making inquiries into the methods adopted abroad to obtain the greatest economic utilization of timbers. Unfortunately, Australia has not awakened to a full realization of her forest wealth, or to the necessity of treating the timber which is used, in an economic manner. In addition to the waste in the forests themselves, there is enormous preventable waste in the treatment of timber. No scientific investigation has been made into the physical qualities of our timbers, and although local users are more or less compelled by force of circumstances to make use of whatever varieties or condition of timber that is made available to them, manufacturers in other countries, with a wider selection to choose from, are chary of employing Australian woods. A member of the Executive Committee of this Institute who recently returned from the United States of America illustrated the disadvantage under which Australia laboured through lack of scientific knowledge of its hardwoods. He was discussing the question of Australian timbers with the President of the Steel Corporation, United States of America, and asked him if he had ever tried them for steam-ship or railway train furnishings. The reply was that nothing definite could be ascertained about their special suitability. It appeared that American users were favorably impressed by the appearance of the wood, but were taking no chances with its utilization. Mr. Boas indicates the scope of the research carried out in the United States of America, and his report, which he is now compiling, should prove of value to the Commonwealth. He has been appointed for twelve months to act as Forest Products officer for the Institute, and it is hoped that before that period has expired a commencement will have been made with a Forest Products Laboratory.

AN AMERICAN INSTITUTION.

The Forest Products Laboratory at Madison, to which Mr. Boas refers, is an institution of industrial research devoted to the study of properties and economic uses of wood. In many cases investigations are conducted in co-operation with the wood-using industries to develop new processes or methods having economic value. Results, so far as possible, are checked by application on a commercial scale, and no investigation is considered completed until the industrial value is established. All information secured is made available to the industries

through publications, co-operative reports, technical notes, and correspondence. The value of the information disseminated by this laboratory is known to any one familiar with its publications. The technical notes are eagerly looked for by the various industries as they contain practical suggestions as well as new scientific data.

GREEN AND SEASONED TIMBERS.

One of the many "technical notes" issued last year by the Madison Forest Products Laboratory contains the results of an investigation into the comparative durability of green and seasoned timber. Opinions of wood users have always differed as to the comparative durability of untreated green and seasoned timbers when used for poles, posts, or ties. Recent experiments conducted by the Laboratory indicate that there is practically no difference in the relative durability of untreated green and seasoned timbers when exposed to the weather and in contact with the ground. Tests carried out with Western Larch and Douglas Fir in the hot plain country and the cold mountainous regions bear out this conclusion, since in each case the average life of the seasoned ties was only one-tenth of a year longer than that of the green ties. These tests were carried out in co-operation with the Northern Pacific Railway. Periodical measurements on poles, made by the Laboratory in co-operation with the American Telephone and Telegraph Company, show that the rate of decay in green poles is a trifle less than in seasoned poles. The fact that green and seasoned timber have the same durability when used in exposed situations is easily explained. Moisture content, it is pointed out, is the principal factor in determining the rate of decay of a stick of timber. As soon as the timber is placed it begins to give off or take up moisture, according to its condition of seasoning and the conditions of exposure. Within a relatively short time in exposed construction both green and seasoned timber reach the same moisture content. When used in buildings, however, wood does not usually dry out rapidly after being placed. Wood for interior construction must be seasoned before use, otherwise it is likely, not only to shrink to a serious extent, but also to decay before it seasons. Very expensive building repairs have been necessitated by the use of green timber.

WORM NODULES IN CATTLE.

Approval has been given by the Minister (the Hon. W. Massy Greene) to an expenditure of an additional £250 during the remainder of the financial year for a continuation of the investigation into the cause of worm nodules in cattle. The object of the work for which the original grant was made was to continue the investigation from the stage arrived at by previous investigators, and to ascertain the means of transmission of the worm nodule parasite (*Onchocerca gibsoni*). The special committee has submitted twelve progress reports to the Institute, and a large amount of valuable work has been carried out. Recent experiments with calves on Rabbit Island, in the Hawkesbury River, confirmed evidence previously obtained at Kendall incriminating a species of march fly as the agent by which the nodules are transmitted. Every effort will be made to obtain definite results during the ensuing

fly season, and the experiments will be designed to—(*a*) prove by mass infestation of calves kept in fly-proof cages that the *Onchocerca gibsoni* is transmitted by a march fly; (*b*) prove by specific infestation which species of the march fly acts as the intermediate host; (*c*) study the development of the larvæ in the march fly, both naturally infested and artificially fed on worm nodules; (*d*) study the life history of the march fly to ascertain its most vulnerable period; and (*e*) carry out further observation relative to the life history of the worm in infested cattle.

POWER ALCOHOL FROM MACROZAMIA.

The results of the experimental work on macrozamia published in the December issue of this journal show that the yield of alcohol obtainable from the palms, including both the inner and outer cores, is about 14 gallons per ton. The New South Wales Forestry Commission states that the District Forester at Moruya has made inquiries as to the price at which the palms could be delivered. The only quotation received by him for obtaining and delivering the whole butts of the zamia palm, *i.e.*, with only the leaves cut away, is at the rate of 32s. 6d. per ton. This price is considered to be unreasonable, and the District Forester states that there are many places on the Clyde River where good wages could be earned by obtaining and delivering the butts at log wharfs or loading places at prices ranging from 12s. to 14s. per ton. If, therefore, the butts could be delivered at the lower figure specified (12s. per ton), the cost of the raw material would be approximately 10d. per gallon.

WEIGHTS AND MEASURES.

At the request of the Commonwealth Board of Trade, the Institute recently made inquiries into the Weights and Measures Acts and Regulations of the various States, and an examination of the position as it affects the Commonwealth. After consultation with experts and consideration of the legislation, the Executive Committee expressed the opinion that in some of the States the Acts are out of date and unsatisfactory in various respects, and suggested that the only way in which satisfactory control of weights and measures would be established in Australia would be for the Commonwealth to provide by legislation for a complete system of supervision and inspection. The establishment of an efficient system of control could not be attained, however, unless a Bureau of Standards were organized and equipped. It was pointed out that this course would involve considerable time and expense, and it was one of the matters which it is contemplated will be taken up by the permanent Institute of Science and Industry. It was thought probable that the system would become self-supporting by the receipt of fees soon after its inception. "The establishment of such a system," concluded the report, "is considered to be of the highest importance to the commercial, industrial, and general interests of the Commonwealth, but the Executive Committee does not think it desirable to expend the necessary time and money in inquiring into the matter further, unless the Commonwealth Government proposes to take the matter up with a view to control on a Federal basis."

GLASS RESEARCH ASSOCIATION.

At the present time there are approximately 400 firms in the United Kingdom engaged in glass and glassware manufacture. They employ about 50,000 workers. Under the ægis of the Department of Scientific and Industrial Research, a Research Association has been established, and it is expected that, before the scientific work of the association is actually commenced, every one of these 400 firms will have applied for membership. The importance of the industry has led the new Department to generously subsidize the investigations, and a sum not exceeding £75,000 will be granted from public funds within a period of five years, on condition that during this period members of the association contribute an aggregate sum of not less than £5,000 a year in subscriptions.

THE GLASSWARE INDUSTRY.

It is now widely known that, among the industries which have been profoundly influenced by the war, the glass and glassware industry of the United Kingdom occupies a foremost place. Not only have the pre-war products of this industry, as they existed in this country before the war, been found essential for a wide range of national purposes during war-time, but the necessity has also been forcibly realized for creating certain special sections of this industry, previously non-existent in the country, to supply glass and glassware, glass instruments, and glass apparatus directly necessary for the prosecution of the war, as well as similar articles equally vital as being indispensable for the efficient operation of other industries. The importance of the glass industry to the economic life of the nation is to be measured largely by its effect upon, and indispensability to, other industries. This has been fully recognised by the Government in the inclusion of scientific glassware and illuminating glassware, as well as optical glass, in the schedule of unstable "key" industries. But the revolutionizing effect of the war upon the glass industry is not alone manifest in the creation of these "key" sections which previously were monopolized by Germany and Austria, whose glass manufacturers had attained great influence and reputation, and certainly dominated the markets of the world, or even in the resuscitation of other sections (*e.g.*, the so-called "flint" glass sections) of the industry, which, though long established in this country, were rapidly declining as the result of unfair foreign competition. The feature even more significant than either of these, and the ground of the future hope that a stable and prosperous British glass industry will be firmly established, is the shedding of the old spirit of isolation and exclusiveness which possessed the manufacturers of this country. Invariably in each works there existed a policy of secrecy, together with an unwarranted satisfaction with old-fashioned rule-of-thumb manufacturing ideas and an absence of scientific method. This inevitably resulted in inability to organize for production upon progressive modern lines. During the war there has been a wonderful awakening to the new possibilities of glass production in this country, and there is now happily evidenced among the manufacturers a new spirit of co-operation combined with an enthusiasm for investigation and research, and a desire to adopt new methods and equipment involving the scientific control of manufacturing operations.—*Nature*, vol. 104, p. 299.

INTERNATIONAL STANDARDIZATION OF ELECTRICAL MACHINERY.

A great deal of valuable work in the direction of the international standardization of electrical machinery, plant, and equipment has been carried out by the International Electro-technical Commission. Although it has maintained its organization intact, that body did not hold any meetings during the war. At the first meeting after the war, held at London in October, 1919, it was decided to re-appoint the various committees which were at work before the war, and to appoint some additional committees. There are new eight committees at work, viz.—(*a*) Nomenclature; (*b*) Rating of Electrical Machinery; (*c*) Symbols; (*d*) Nomenclature of Prime Movers for Electrical Plant; (*e*) Aluminium, standard of resistance; (*f*) Screw Lamp Caps and Lamp Holders, interchangeability; (*g*) Charging Plugs for Electrical Vehicles, interchangeability; (*h*) Pressures for Distribution. A meeting of the Commission will be held this year in the United States of America.

THE ENGLISH DYE INDUSTRY.

Lord Moulton does not share the prevailing fear that Germany is going to assume again quickly the dominant position in the production of dyes. Speaking recently at an open meeting of colour users, he spoke of the precautions taken to prevent such control. During the war he was astonished that England, so utterly unprepared with ready-made chemical industries, could respond to the colossal demands upon it, and could at once overtop the great chemical industries of Germany in a war that turned upon chemistry most of all. He had learned that, again and again, the Germans were on the verge of failure to meet the demand for ammunition, again and again were driven from one expedient to another, and again and again their chemical industries came to the assistance of the nation with devices which reflected the greatest credit on their scientific power and originality. The factories which we had to build to supply the demands of the war were now disappearing, because they were set up purely for war purposes, whereas the Germans, in their enlarged chemical factories, in the swollen establishments of all their dye firms, had a wealth remaining behind which, although created for war, was still serviceable in peace. The great German dye industry, supported by the Government very largely during the war, accumulated large stocks. England had been starved of them, except in so far as her own efforts have been able to create industries to make dyes under the difficult conditions of war time. Therefore the first reason for the clause of the Peace Treaty, which gave the Allies the right to part of the German stocks of dyes, was to insure that the world would not be at the mercy of Germany, because Germany possessed the only stocks of dye. For that purpose it was provided that 50 per cent. of those stocks should be taken, by way of reparation, at a price to be settled by the Allies, and to be credited to the reparation fund. The other part of the clause was intended to protect us in the future.

COUNTER-STROKE TO GERMAN MONOPOLY.

Forty years of growth, assistance from the German Government, and our own negligence, and that of other nations, in regard to chemical industries, had, Lord Moulton said, left Germany in a position to produce

special dyes to an extent far greater than any other nation could cope with. Consequently, we provided that Germany should no longer be able to "corner" the dye industry by insuring that, for five years, 25 per cent. of her total production should be capable of being bought at the option of the Allies at a price which should be reasonable, at all events as low as the price at which they sold to any other nation. He had been delighted to read, in a German industrial publication, an article protesting that it would make impossible the favorite German "full line system" of selling, under which their manufacturers refused to sell a particular dye unless the customer bought all his other dyes from them. It was exactly for that purpose that the clause was inserted, to prevent a German monopoly of dye production. The operation of this provision was limited to five years, because its purpose was to stir up England to help herself. To extend the provision over a long series of years would lead us to put off the time when we should apply ourselves to the formation of this industry. If the industry could not within five years become strong enough to bear its burden, and to hold its own against the chemistry of Germany, it did not deserve assistance. The time had already come for the 50 per cent. provision of the Treaty to be carried out. Remarking that he had been invited by the Board of Trade to be the English representative at Paris on the committee which was dealing with the 50 per cent. and its division among the Allies, Lord Moulton said that the committee had agreed, without prejudice to the ultimate proportion of the shares, that certain advances should be made out of these stocks. Italy, France, and Belgium together were allotted 2,200 tons; we had the right to take 1,500 tons, and America also 1,500 tons. The first consignment of our 1,500 tons, he believed, was now on the eve of arriving in this country. It started from Germany several days ago. He did not think there was any foundation for the idea that other nations were getting their shares more quickly than ourselves.

THE AMALGAMATION AND TRADE PROSPECTS.

Alluding to the position created by the amalgamation of British Dyes Limited with Messrs. Levinstein Limited, Lord Moulton said he found himself at the head of this great concern, which had a great honour bestowed upon it by the Government consenting to become a co-partner instead of a creditor. Since then it had received a proof of the country's confidence in a subscription of five millions. They had, in his opinion, such a staff that there was no dye of any importance which they were not prepared to make when they had the plant. The idea that there were secrets unknown to them, ignorance of which paralyzed their efforts, was absurd. It was naturally true that the experience of the Germans had given them skill in getting the last bit of yield out of a combination. It must be remembered that the German combine was one, not only of dye works, but of chemical works of all kinds, pooling their profits, and capable, therefore, of selling any particular class of things at a loss, if necessary, in order to destroy a formidable growing industry in a foreign country. Such a combine as that, possessing the sort of morality revealed in the reports published by the American Government, was sure to give the British company trouble, and, if they intended to give trouble, it could be done through the most honest and well-meaning people. He said he was not surprised at the attacks made in some quarters upon the company. He never expected that England

would take up the job of fighting the huge combine that existed in Germany without the persons who were doing it catching it. One attack which made him very indignant was a suggestion of watered capital, and that there was an inflation of values and the ordinary abuse of the Stock Exchange with regard to it. It was utterly unjustifiable, and absolutely untrue, to suggest that there was anything like watered capital in the company. Dealing with complaints by users that they could not get the quantities they received before the war, he said it was impossible for a company so young at once to give a full range in such quantities as might be demanded. Increase in range was not the solution, because they could give a very large range indeed in quantities insufficient for the industry. They had to aim at satisfying in quantity as well as in the nature of the demand, and they were doing that as fast as they could. They produced more indigo now than England could consume, whereas, at one time, users were standing in queues for indigo. It seemed to him that no one was held up so that his works could not do their full amount. He was only held up in the sense that he would rather be making other things than those he happened to be making. "When I spoke to you last," said Lord Moulton, in concluding, "England produced only one-tenth of the dyes you wanted, and I am informed that by the end of this year we shall be able to turn out within one-fifth of the amount that England used before the war. The tables are turned. The margin that you want imported is a small part; that which we make is the bigger. That is not a bad account of work done under the paralyzing influences of war, and the almost equally paralyzing influences of the last few months."

SYNTHETIC AMMONIA: NEW FRENCH PROCESS.

Professor D'Arsonval, according to a *Times* correspondent, made an important communication, in the name of M. Georges Claude, to the Academy of Science, Paris. M. Claude recently showed that, contrary to the generally received theory, it was not only possible but strikingly easy to produce and turn to industrial uses pressures of 1,000 atmospheres and more. M. Claude has now succeeded in applying these very high pressures to the synthetic production of ammonia. Hitherto this has been done and applied only in Germany. M. Claude, however, has far outdistanced the German chemists. Under the new conditions discovered by him the combination of hydrogen and nitrogen takes place with such intensity that a very small apparatus is capable of a considerable output. M. Claude proposes shortly to exhibit to the members of the Academy a tiny apparatus, in regular working order, capable of producing daily 200 litres (44 gallons) of liquid ammonia. Whereas the German chemist Haber only obtains one-third of a gramme of ammonia per catalytic gramme, M. Claude obtains ten grammes.

RESEARCH ON PETROLEUM PROBLEMS.

Arrangements have been made by the American Petroleum Institute for the organization of a Division of Research and Statistics. The amount to be expended is placed at about £100,000 annually, which the industry can well afford, as this sum is only one-fiftieth of 1 per cent. of the value of the 1918 output of crude oil and refined products in the

United States. The plan provides for a Technical Director, in general charge of all the work, assisted by consulting experts, who are to serve without pay. In addition, there will be an Advisory Committee, to meet regularly, consisting of one representative from each of the following:—Bureau of Standards, Bureau of Mines, Geological Survey, Society of Automotive Engineers, National Automobile Chamber of Commerce, American Institute of Mining and Metallurgical Engineers, American Society for Testing Materials, American Chemical Society, and the National Research Council.

The principal officials under the Director are to be the Chief Economist and an Engineer. The economist will be in charge of statistics, economic phases of the industry, and publicity. He will also give particular attention to international policies affecting the petroleum industry of the world. The engineer of the division will co-ordinate the research work undertaken by the Subdivisions of Production, Chemical Engineering, Utilization, and correlated activity. Systematic study will be made of the questions of leasing and bonuses, drilling, pipe lines, storage, and tank cars, and active steps will be taken in an effort to improve the internal-combustion engine for use of heavy oils. The policy of the American Petroleum Institute, it is announced, will be to employ only the highest type of men, and to pay them salaries attractive enough to insure continued service.

NEW POTASH SOURCE IN NORWAY.

The outbreak of war and the inability to secure supplies of potash from Germany compelled serious consideration in the United States, in Great Britain, and in other European countries of other sources of supply. Flue dust was regarded as one of the most likely means of providing the deficiency, and for a long time investigations have been made into the possibility of obtaining supplies on a commercial basis. The relatively low percentage of potassium present in the dust has proved a very great difficulty. It is reported from Norway, however, that with the cement manufacture at Dalen, near Brevik, there will be connected in the near future Cottrel apparatus for getting the potassium out of the dust. The raw materials for the cement contains 1.5 per cent. potassium, and they intend to have a production of 150,000 tons cement and 1,800 to 3,000 tons potassium (K_2O) per year. If all cement manufacturers in Norway would take care of the dust it is estimated they would get as much potassium as is now imported from Germany.

SODIUM CARBONATE IN CANADA.

Glass manufacturers in Canada have been largely dependent in the past upon the United States for their supplies of glass sand and sodium carbonate. However, according to the United States Bureau of Mines Report, the new plant at Amherstburg, Ontario, Canada, at which sodium carbonate is to be made by the Solvay process, is expected to supply all of Canada's needs for soda ash. The capacity of this plant is reported to be about 120 tons per day. Some glass sand is being secured from Oneida, Ontario, but it is said to be of an inferior grade, and only suitable for the manufacture of the cheaper grades of glassware.

INSECT PESTS IN WHEAT.

In the *Review of Applied Entomology* of November last an abstract is published of the methods for dealing with weevil-infected wheat. Owing to shipping difficulties, arising out of war conditions, wheat has had to be stored for an unusual length of time in Australia. No provisions had been made for the accumulation of such large quantities, and ample opportunities were thus afforded for infestation by weevils and other insects. In grain eventually shipped to California the following beetles were found:—*Calandra oryzæ*, *C. granaria*, *Tribolium confusum* (confused flour beetle), *T. castaneum* (*ferrugineum*), *Silvanus surinamensis* (saw-toothed grain beetle), *Rhizopertha dominica* (lesser grain borer), *Læmophloeus minutus* (flat grain beetle), and *Tenebroides mauritanicus*. The cosmopolitan parasite of grain weevils, *Mesaporus calandraæ*, How., was also very abundant. On arrival at San Francisco some of the sacks had as much as 80 to 90 per cent. of their contents injured by weevils. The grain was taken straight from the docks to the mills, where it was passed through the usual screens to remove the straw, unthreshed heads, and other rubbish. Before use it passed through suction cleaners, that draw off the light grain, weed seeds, weevils, &c. These screenings, if containing very many beetles, were burned, but if a good deal of grain were retained, were used as food for pigs, sheep, or poultry. All mills handling this infested wheat were urged to make some provision for the destruction of the insects. Experiments made show that exposure to heat, with a steam pressure of 80 to 150 pounds, for twelve hours, killed all the beetles. Various kinds of boxes and rooms were equipped for this purpose. In some cases the wheat was sprayed by means of hand-pumps with carbon tetrachloride at the rate of 2 U.S. gallons of liquid to 30 tons of the grain. Wheat treated in this way is not injured, and if the bins are tightly closed for at least two or three days, all weevils in them will be found dead.

PROPERTIES OF DERRIS.

Experiments on the properties of Derris as an insecticide are described in the current number of the *Review of Applied Entomology*. Though commonly known as Derris, the correct botanical name of plants of this genus, which belongs to the *Papilionaceæ*, is *Deguelia*. They are found throughout the tropics, but are more abundant in the Old World than in tropical America. These plants have long been known as fish poisons, for which purpose the roots are pounded into a pulp. Although Derris may prove useful as a contact insecticide and as a stomach poison, it is of no value as a fumigant. As the material must be imported, only dried roots and stems are available. Tests were made with petroleum ether, ether, chloroform, alcohol, and water as solvents, and the results show that petroleum ether is a poor solvent, while the others may be considered good, though only alcohol and water can be regarded as economically useful, the best results being obtained with denatured alcohol. Details are given of the experiments made with various species of Deguelia. Alcoholic extracts of *D. elliptica*, *D. uliginosa*, and *D. koolgibberah* were generally efficient, while those of *D. oligosperma*, *D. scandens*, and *D. robusta* were only seldom so; the powder of an unidentified species mixed with water or soap solution was usually efficient, while the other powders tested by this method were found ineffective; of

eight powders used as dusts, only *D. elliptica* and *D. uliginosa* and an unidentified species were found efficient. Used as a powder, Derris was found to be equally effective against *Ctenocephalus canis*, Curt. (dog flea), *Mallophaga* on poultry, and *Musca domestica*, *L. Dermanyssus gallinæ*, Redi (chicken mite) was killed in twenty-four hours when confined to jars, but under natural conditions all the mites were not killed. It is of very little value against *Cimex lectularius*, L. (bed-bugs), *Phyllodromia (Blattella germanica)*, L., *Pseudococcus citri*, Risso (mealy bug), *Orthezia insignis*, Doug., *Tetranychus telarius*, L. (*bimaculatus*, Harv.) (red spider), and the crawling young of the oyster-shell scale, *Lepidosaphes ulmi*, L., but was effective against *Aphis rumicis*, L. (bean aphis) and *Aphis pomi*, De G. (green apple aphis). Used as a spray, it proved effective against *Aphis pomi* under natural conditions. The sprays were applied with and without soap at strength varying from 1 lb. of powder in 25 gallons of water to 1 lb. of powder in 200 gallons of water. Even the weakest solution resulted in the death of 98-100 per cent. of the aphides. The soap does not increase the effectiveness. Under greenhouse conditions it proved effective against *A. rumicis* at the rate of 1 lb. of powder to 400 gallons of water, with the addition of soap at the rate of 1 lb. to 100 gallons of water. Used as a stomach poison against *Leptinotarsa decemlineata*, Say (potato beetle), at strengths ranging from 1 lb. of powder to 16 gallons of water up to 1 lb. to 128 gallons, it killed all larvæ within forty-eight hours. Other insects against which it proved effective include *Malacosoma americana*, F. (tent caterpillar), *Hyphantria cunea*, Dru. (fall webworm), *Anisota senatoria*, S. and A. (oak worm), *Datana ministra*, Dru., and *Phytometra (Autographa) brassicæ*, Riley (cabbage looper). Some insects are more easily affected than others, but apparently death eventually occurs in all cases through motor paralysis. The toxic principle is probably a resin.

EFFECT OF SHEEP DIPS ON WOOL.

The effect of sheep dips on wool was the subject of an interesting lecture before the Leeds University Textile Association by Dr. Sydney Williamson, of the Cooper Research Institute. The whole discussion as to the effects of dips on wool, said Dr. Williamson, had unfortunately centred mostly in the lime and sulphur dip, the one which the farmer himself made for the sake of cheapness. That dip was opposed by the manufacturers of the proprietary dips. In spite of much research for authentic evidence as to the injurious effects of dip upon wool, he had come across nothing which could be regarded as conclusive. He expressed the opinion that nicotine in dip was not injurious so long as pure nicotine was used. Carbolic acids, as a rule, were only injurious if they contained an excess of alkali, which tended to disintegrate the fibres. If a farmer used impure tar oil in dipping, he might get wool which, after scouring, would turn almost brick-red in colour, but such instances were rare. With regard to the lime and sulphur dip, he had seen a great deal of wool which had been injured. It had become harsh, and had lost its lustre, a condition which was probably due to the deposition of lime, which formed salts in contact with the fats in the wool. These lime salts were probably deposited in the fibre, but he had never been able to prove it. Speaking in regard to arsenical dips, Dr. Williamson said they were not injurious unless an excess of alkali had

been used in making the arsenic soluble. On the whole, he was inclined to believe the arsenical dip improved the wool, but it was exceedingly difficult to prove.

ANTI-TICK CAMPAIGN IN AMERICA.

More than 50,555 square miles were freed of the cattle fever tick in the United States during 1919. The Bureau of Animal Industry announced that on 1st December the quarantine against the movement of cattle would be lifted from 46,921 square miles. An area of 3,634 square miles was released on 15th September. The 1919 releases do not make the year, in point of territory placed in the free area, the greatest year for tick eradication, but they indicate much consolidation work and "mopping up" in areas previously released. In 1906 the quarantine line extended from Virginia to Texas, and re-appeared in California. The attack against the parasite has driven it out of California, Missouri, Kentucky, Tennessee, South Carolina, and Mississippi—completely the infected portions of the four States first named, and sufficiently in the last two to justify their release from quarantine. The territory released this year is in six States: 2,991 square miles in Alabama, 9,299 square miles in Louisiana, 8,847 square miles in Texas, 8,130 square miles in Arkansas, 6,942 square miles in Georgia, 4,346 square miles in Oklahoma.

NEW SPECIFICATION FOR INSULATED CONDUCTORS.

The British Engineering Standards Committee have issued a new specification for insulated conductors for electric light and power purposes which differs radically from its predecessors. The basis of this is a table giving a series of thirteen wires, ranging in diameter from .0076 inch to .1030 inch. From these wires are drawn up a table of solid and stranded conductors ranging in area from .0010 square inch to 1 square inch, there being twenty-four sizes. Corresponding to the standard, ordinary conductors are the tables of flexible conductors. The first is for flexible cords, and comprises six sizes, which are substantially those now in ordinary use. The final table is of flexible standard conductors corresponding in area to the areas of the main table.

ALCOHOL FROM COKE OVEN GAS.

In a paper read by Mr. Ernest Bury, of the Skinningrove Iron and Steel Works, to the Cleveland Institution of Engineers, he stated that at the Skinningrove works he had succeeded in extracting ethelene, alcohol, and their derivatives on a commercial scale from coke-oven gas. The work is still, to some extent, in the experimental stage, but Mr. Bury has succeeded in producing a perfect motor spirit. The world's liquid fuel resources are strictly limited, whilst the consumption is growing by leaps and bounds. The practical working of Mr. Bury's process at the Skinningrove works, where 5,800 tons of coal are carbonized per week, has revealed an average yield of 1.6 gallons of alcohol per ton of coal carbonized, and as the total weight of the coal which was reduced to coke in Great Britain in 1918 was 14,635,000 tons, the application of this process to the whole of this coal would yield, according to Mr. Bury's calculation, 23,416,640 gallons of alcohol, representing, at 2s. per gallon,

a sum of £2,341,664. Having regard to the scarcity of liquid fuel, that in itself is important, and, as Mr. Bury declared, it is national suicide to continue to burn any substance which can be converted into liquid fuel. But the possibilities do not end there. He pointed out that the recovery of alcohol at the gasworks of the country would yield a further 27,000,000 gallons, or, taking alcohol and benzol together, the total quantity of liquid fuel available for extraction through the carbonizing of coal would be 114,000,000 gallons, as against the country's present total requirement of 160,000,000 gallons per annum. The process of extract by contact with sulphuric acid is not a new discovery, but Mr. Bury has been the first to establish it as a commercial proposition. His principal discovery is that the best results are achieved at a temperature of 60 to 80 degrees Centigrade, and in his process he has carried the utilization of heat from the coke-oven plant to the utmost limit. Ether, chloroform, iodoform, acetic acid, and acetone are amongst the derivatives he has obtained from this coke-oven gas after the benzol has been extracted; and, at the meeting at which the results were disclosed, some of the foremost metallurgists of the day, amongst them Dr. J. E. Stead, paid tribute to this brilliant young scientist, and also to the progressive policy of the company at whose works these experiments were carried out. Skinningrove was the only ironworks in the country which during the war produced T.N.T. for the Ministry of Munitions, and produced it on a prodigious scale. At Skinningrove, too, was installed one of the first plants for extracting potash from blast-furnace dust, and the policy of the firm in encouraging research and experimental work is an indication of a new spirit amongst the leaders of industry, who are now showing an appreciation of the true value of the scientist in the development of new methods of manufacture.

RESEARCH IN CONCRETE.

The more recent activities of the British Department of Scientific and Industrial Research include the formation of a British Portland Cement Research Association. A Building Materials Research Committee has been at work for some time, and it is expected that a report will appear very shortly. This committee has superintended investigations at several different centres, tests of floors having been made at the British Fire Prevention Committee Testing Station, experiments on the properties of mixtures of lime and cement at the L.C.C. School of Building, Brixton, tests on the passage of gases through various materials for the construction of walls at the National Physical Laboratory, and tests on thin walls and on the properties of slag and coke-breeze aggregates in other laboratories. A separate committee is dealing with the possible use of certain local materials for building purposes. The public interest taken in the housing question at the present moment, and the fact that the British Government has made itself responsible for the progress of housing schemes, have made it essential that researches of this kind should be pushed forward as rapidly as possible, in order that materials may be employed in the most economical manner, due regard being paid to safety, comfort, and permanence. The co-operation of the geologist is evidently called for in this connexion, and it may be noted that the organization of the Geological Survey, which has rendered such excellent services to science and to the nation

in the past, is to be taken over by this Department. By arrangement with the Board of Agriculture, a series of five experimental cottages is being erected on land belonging to the latter body, the experience gained during the work to be utilized by those departments which are concerned with the provision of houses for agricultural workers. Among the researches which have been assisted by grants, a special reference is made to that undertaken by the British Fire Prevention Committee into the ability of various kinds of concrete, plain and reinforced, to resist the action of fire. This matter is so urgent, in view of the extensive construction with modern materials which will shortly be in progress, that the information obtainable is required as early as possible, and every effort is being made to complete the work.

HELIUM—A NEW CANADIAN COMMERCIAL ASSET.

That Canada will soon produce helium in commercial quantities is the confident opinion of some of the best known of Canadian scientists. As a non-inflammable substitute for hydrogen gas used in dirigible balloons it has been found most valuable, and as a commercial product its value is enhanced by its comparative scarcity, Canada and the United States being, as yet, the only countries in which it has been found. In Canada it is derived from the natural gas fields of Southern Alberta. Professor J. C. McLennan, Professor of Physics in the University of Toronto, who, during the war, acted as adviser to the British Admiralty, brought the attention of that body to the fact that it could be used as a substitute for hydrogen gas. Under the direction of the Admiralty, a series of extensive investigations and experiments were conducted under the supervision of Mr. Eugene Coste, President of the Canadian Western Natural Gas, Light, Heat, and Power Company, at the Calgary plant of this corporation. The Canadian natural gas in which helium exists was found to have an advantage, as it proved to be much more readily broken up into its constituent parts, the helium being extracted by first liquefying the methane, which is one of the constituents, then liquefying the nitrogen, which left the helium free. Experiments are now being conducted at the University of Toronto to discover if there are other uses to which helium can be put than solely as a buoyancy producer for lighter-than-air craft. In discussing the subject of helium before a Parliamentary Committee, Professor J. C. McLennan recently said—"In 1903 it was observed that many of the natural gases of Canada contained a small percentage of helium. In the spring of 1916 it was found that the largest supply of natural gas in Canada, namely, that located at Bow Island, Alberta, contained a little over 0.36 per cent. of helium. This is comparatively small, and apparently an insignificant amount, and yet I may tell you that this wonderful gas was so rare and so costly that at pre-war prices the value of the supply of it which escaped into the air from the furnaces and stoves of Calgary and other houses on the pipe line was 50,000,000 dols. per day. By the developments which have taken place during the past two years the cost of producing the gas in a pure state has been reduced, roughly, 100,000 times. Owing to the advance, it became possible to utilize this gas in place of hydrogen in lighter-than-air aircraft. With the buildings and plants projected by the Admiralty and the authorities of the United

States, we should, had the war continued, been able, by June of this year, to produce about 2,000,000 cubic feet of this gas per month for use in our balloons at the Front. This would have meant the creation of a great industry in Canada. Although it will not pay to use the gas for balloons under peace activities, every effort is being made to develop technical uses for this gas, and it is possible that it may yet be required in large quantities for the production of gasfilled lamps and other articles of commerce." Further investigating and experimenting have led to the confident prediction that helium will soon be included among the valuable commercial products of the Dominion. Incidentally, this is a tribute to the work of scientific and industrial investigations now being conducted in Canada.—(*Chemical News.*)

RESEARCH.

Speaking at a conference of representatives of research organizations connected with the Department of Scientific and Industrial Research at the Institution of Civil Engineers recently, the Right Hon. A. J. Balfour said it was evident that the industrial progress of mankind in the near future would more and more depend upon the alliance of science and industry and upon the co-operation of different branches of science with each other. The great industrial development in which Great Britain led the way towards the end of the eighteenth century—that gave her a manufacturing supremacy over the world, which it is certainly impossible, and probably not wholly desirable, that we should ever regain—was not in the main due to anything which pure science contributed to industry, and he believed that it was partly owing to the fact that the great industrial community of this country failed to see as fully as was desirable that science was an essential element in industrial progress. The Germans, whose industrial development came much later, took a different view. He did not think that they showed any greater aptitude for science than Britons; but, beginning, as they did, rather late in the day, with their great powers of governmental organization, with their highly developed and equipped universities, and with the view which they had always entertained of the close alliance that ought to exist between knowledge and power, they naturally and easily did what we, with more difficulty and at a later date, were beginning to do. They saw how close was this co-operation, how absolutely necessary it was, not merely in the competition of people with people, of industry with industry, but they recognised, too, that it was only upon our increasing knowledge of the powers of nature that we could expect to improve the material lot of man. The thing, continued Mr. Balfour, which was really going to make a difference in the future, to make the remainder of the twentieth century different from the nineteenth century and the twenty-first century different from the twentieth, was the command, for industrial purposes, which man had over the forces of nature. That could only be attained, in the first place, by the cultivation of pure science, of science for itself, of knowledge for its own sake. It could only be if we strove to breed and to educate men who, without any thought of self-advancement, were consumed by a curiosity to know, and, that end having been attained, then to learn how to apply the knowledge which they had disinterestedly acquired to the great purposes of industrial development.

NEW JAPANESE STEEL PLANT.

Designs have been prepared in the United States of America for a steel plant, intended for shipment to the Kinshu works at Yawata, Japan, the estimated cost of which is £750,000. The whole plant will be electrically driven. The initial plant will include three 50-ton basic open-hearth furnaces, a 20-unit producer plant, an 84-in. plate mill, and a 24-in. structural mill. Later, a motor-driven, 35-in. blooming mill will be installed. The three basic open-hearth furnaces are served by 21 Smythe gas producers. The 84-in. three-high plate mill, which is nearly ready for shipment, is of the Lauth type, and will be driven by a 2,000 h.p. motor, through herring-bone reducing gears and pinions: the motor running at 420 R.P.M., makes the mill speed 56 R.P.M. Since the company has its own blast furnaces, coal and iron ore mines, and fire-brick plant in China, it will be the most completely self-contained organization in the Far East.

TUNGSTEN POWDER AND FERRO-TUNGSTEN.

Tungsten powder and ferro-tungsten are required in the manufacture of high-speed steel. Ordinary tool steel, which contains no tungsten, loses its temper and its hardness, and so becomes incapable of cutting if it be heated to a temperature well below incipient red heat. As a result, the cutting speed of ordinary tool steels is limited to that below which the heat produced is sufficient to draw the temper or produce this softening. By adding tungsten to the steel in quantities up to as high as 20 per cent. (but generally not exceeding some 15 or 16 per cent., and even less), the steel is changed in quality in such a way that it does not lose its hardness at a dull red heat. Cutting operations can then be carried on at an increased speed, and the output of all machine tools built sufficiently strong to withstand the increased stresses, can be increased to about two and a-half times that possible when ordinary carbon steel is used. This property of tungsten is, of course, enormously valuable in all cases where output is of paramount importance, and in carrying out the shell programme its use was almost essential. Tungsten steels are also required in the manufacture of magnets for magneto-electric ignition machines and other purposes. The tungsten is added to the steel in the form of tungsten powder and ferro-tungsten. Before the war, although attempts had been made to carry on the industry in England, they always failed by reason of German competition, and, in fact, before the war, Germany supplied practically the whole world with tungsten powder and ferro-tungsten—this notwithstanding the fact that the richest mines were in British territory. During the war the manufacture was successfully established in this country, and its importance was deemed so great that it was started in many other countries also, notably America, France, Italy, and Japan. In addition to the form of tungsten powder just considered, there is another particularly pure form of tungsten powder which is required in quite small quantities for compressing into slugs and hammering out into solid tungsten objects such as electrodes for wireless valves, X-ray tubes, &c. These slugs are also drawn down into tungsten wire used in the manufacture of metallic filament lamps. The British output of this particular form of very pure tungsten is not at present up to requirements, though it is hoped that very shortly we shall be able to meet our own needs and also carry on an export trade.

Research Work into Forest Products in other Lands.

By I. H. BOAS, M.Sc.

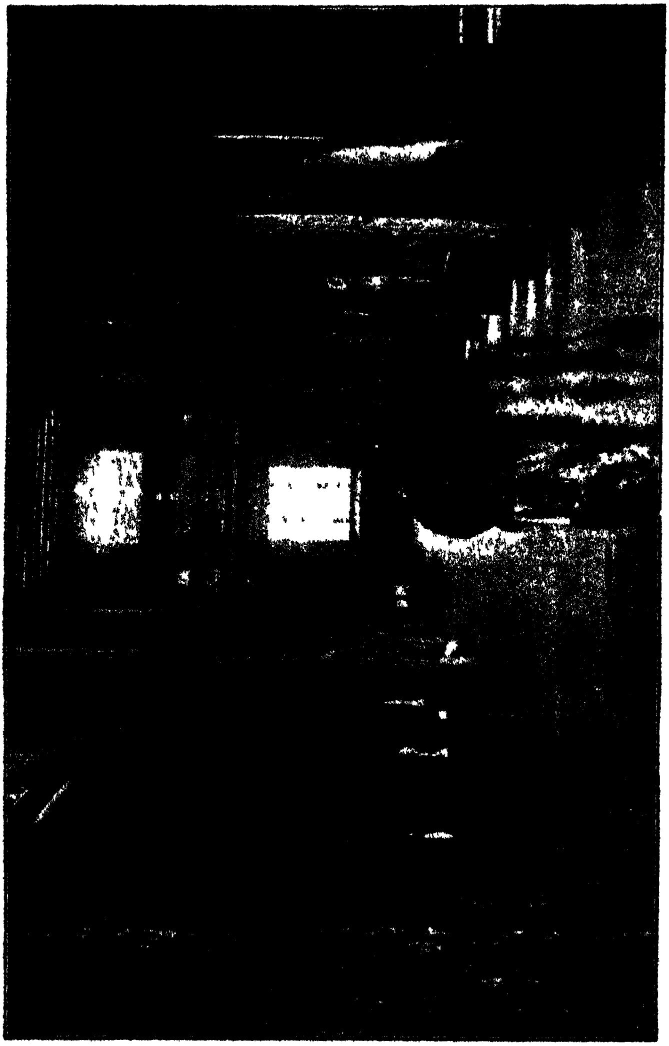
Forest products enter so largely into important industries that isolated investigations into their possibilities have been made in most forest countries for a considerable period. This applies particularly to such industries as paper making, which consumes enormous quantities of timber. It is, however, only within the last decade or so that systematic investigation in centralized laboratories has been undertaken into the many other timber-using industries, and into possibilities of utilizing the varied minor products yielded by forests.

In this work America has led the way, by the establishment of forest products laboratories, and also by enabling the staffs at the Forest Schools to undertake research. In some of these schools, for example, the staff is sufficient to enable each member to spend two terms in teaching and the balance of the year on investigation. This splendid arrangement keeps the staffs always up to date, and reacts most favorably on the teaching work. It also has resulted in much valuable research being carried out.

For example, in the Forest School at Seattle, the staff has done valuable work in timber preservation, timber seasoning, and in other directions. Some of the work is directed to specific problems affecting local industries, and some is of a more general character. Professor Grondal, of Seattle, has developed a method of seasoning low-grade timber in twenty-four hours, without causing any loosening of the knots. Such low-grade timber must be treated quickly, for its value would not bear the cost of the usual slower processes. At this University there is also a complete timber testing laboratory, at which splendid work has been done, especially in demonstrating the possibilities of Douglas Fir (Oregon Pine). This investigation proved of particular value during the war, when stocks of seasoned spruce were unobtainable, and Douglas Fir was shown to be fit for purposes for which spruce had been formerly considered essential. There is a very beautiful Forestry Museum at the Seattle University, built of whole logs of this beautiful tree. The photographs which accompany this article illustrate the artistic effect of this unique building.

In the United States of America there are several other Forest Schools where similar research work is done, but the main investigations are centred at the Forest Products Laboratory at Madison, Wisconsin. This laboratory is under the control of the Federal Forest Service, but is attached to the University of Wisconsin, which provided the site and some of the buildings. The Laboratory is quite free from University control, but members of its staff give courses of lectures to students, and senior students can arrange to do research in the Laboratory. For a few years the institution had a staff of about forty, but this grew rapidly as its work became known, and during the period of the war 450 workers were busily engaged in laboratories occupying ten large buildings. The

war work of the Laboratory was of immense value, not only to the various war activities, but to other industries. A practical evidence of this value was shown by the fact that when Congress threatened the Laboratory grant in the general rush for post-war economy, all the trades which had benefited by its work, bombarded Washington with urgent demands that the grant should be adequate. The result was that the post-war grant is sufficient to keep a staff of 250 workers employed.



INTERIOR OF STATE MUSEUM, SEATTLE.

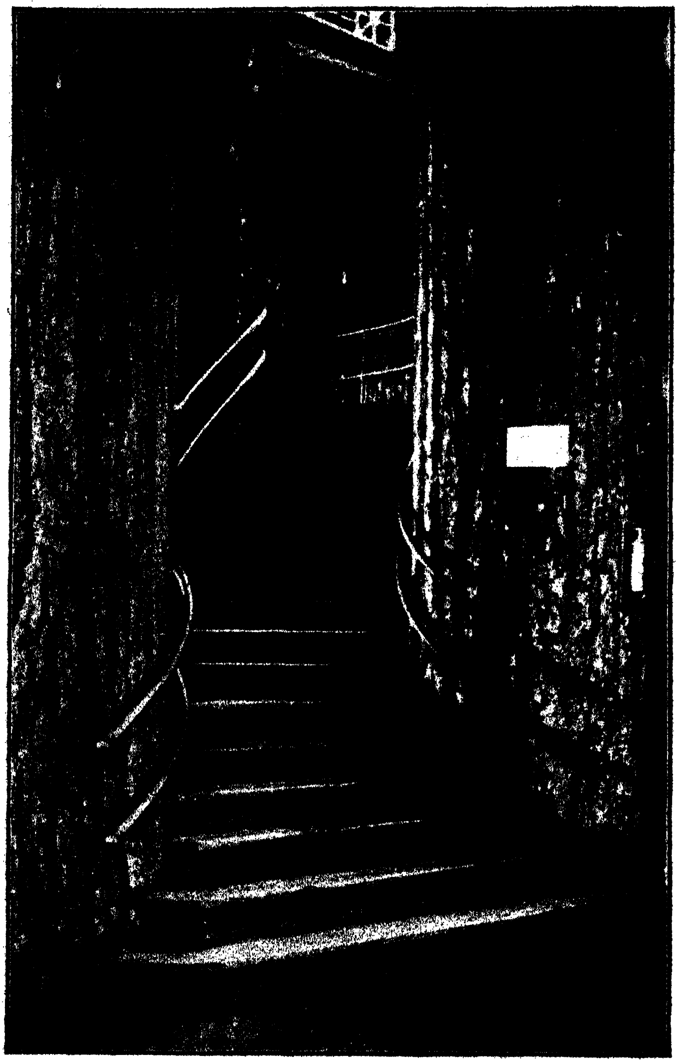
One of the principal activities of the Laboratory has been a most complete physical survey of the principal commercial timbers of the State. In this monumental work hundreds of thousands of measurements have been made, and a staff of thirty women graduates was kept busy calculating the results from the measurements of the investigators.

There is a direct practical value behind these inquiries. The Laboratory is in a position to advise trades that utilize timbers as to what materials are suitable for their particular requirements. Some interesting results followed on the redrawing of war office specifications for boxes for munitions of war, by the Laboratory staff. A saving of 25 per cent. in the cost and 33 per cent. in space occupied was effected. The money value of this slight modification alone ran into hundreds of thousands of dollars during the war. Other directions in which the Laboratory has obtained valuable results are in timber preservation, timber seasoning, prevention of decay of timbers in buildings, prevention of timber diseases in the forests, the utilizing of timber waste, the introduction of new sources of timber for paper making. In these and many other matters the staff of the Laboratory keep close touch with the industries, and a field staff is employed to advise factories, and to bring in new problems of a practical nature for solution. Anything approaching a complete account of the work done in this splendid institution under its able Director, Mr. C. P. Winslow, would occupy more space than is available for this article. Sufficient has been said to indicate the scope of its functions and the value of the results obtained. If Australia can establish a laboratory which, even distantly, approaches that at Madison, there can be no doubt that whatever money is spent will be repaid manyfold. So far from not being able to afford the cost of establishing and maintaining such work, Australia, with its large forests and its huge waste, cannot afford to neglect the pressing need to survey the wide field of research into forest products.

Canada followed the splendid example of the United States by establishing a similar laboratory at Montreal, in conjunction with the McGill University. While this institution has not received the same generous endowments as that at Madison, it has been given a fine equipment, and has done a great deal of work of recognised value. One of its main features is the excellent paper laboratory, with its large machine for making paper on a semi-factory scale. Unfortunately, the Government of Canada has not paid the investigators sufficiently large salaries to prevent the industries from tempting them into the industrial world. The paper trade has always recognised the value of the Laboratory, and has taken advantage of the practical experience obtained there by the workers. The consequence has been that, tempted by generous offers, many of the staff of the Laboratory have recently resigned, and much of the activity of the Laboratory has thus been hampered. Vigorous attempts are being made to overcome this difficulty. Only one way is open, and it is hoped that the Government of Canada will be able to see it, and take advantage of the opportunity that the Laboratory presents, to develop forest industries. A branch of this institution has been established in Vancouver at the University. This branch deals, at present, only with timber testing, much as does the Seattle branch of the Madison Laboratory.

In Great Britain there has been no attempt to carry on any kind of systematic research into forest products utilization. The forest areas are small, and this fact probably accounts for the omission. In a country with small timber resources there is really all the more need for preventing waste and the misuse of that timber, and for insuring all its products are used to the greatest advantage. During the war much work

was done in scattered institutions, particularly on testing timbers for airplane construction, and also in the proper seasoning of such timbers. A good deal of research was also done on timber distillation to produce acetone for cordite manufacture. Several factories were erected and worked to produce this essential material. Following on this experi-



STAIRWAY, STATE MUSEUM, SEATTLE.

mentation, many English firms have erected seasoning kilns of a modern type, and so provided for a far more efficient utilization of timber in the United Kingdom. The need for a central laboratory is clearly indicated by the fact that several Government laboratories were engaged in testing timbers, and each had its own method of testing. The result is that the

data from one laboratory are not comparable with those from the others, and much of the work done thus loses its value. The same conditions apply to such timber testing as has been done in Australia, and one of the first tasks of a Forest Products Laboratory in this country would be to standardize all such work, and thus obtain data that will be of the greatest value to our timber export trade. Plenty of evidence is obtainable to show the harm done to the reputation of our timbers, due to a lack of such information.

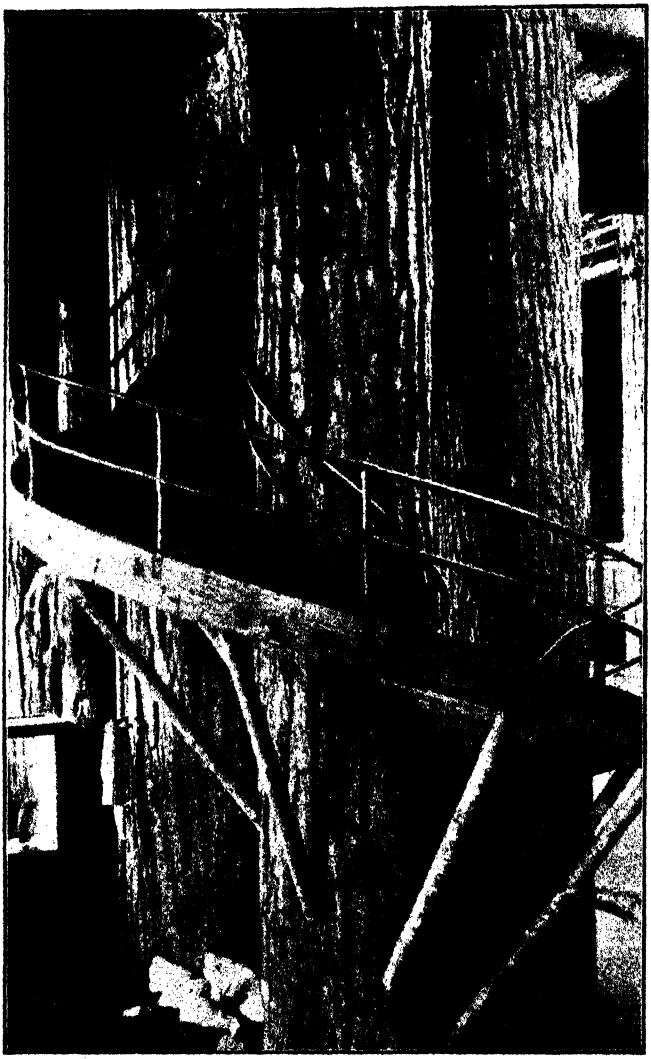
In Norway, in spite of its large forest areas, nothing has been done in the direction of research with the idea of preventing waste, and probably that country will be faced with a grave situation in regard to its forests before this is done. It is a pity that it usually needs such a crisis to sufficiently awaken public feeling to a sense of what is proper.

In France a great deal of work has been done, but it has been very sporadic. The paper school of the University of Grenoble has done a great deal for this particular industry. Incidentally, at this school an investigation into the possible utilization of Australian Eucalypts for paper making was carried out. Immature trees of *E. Globulus* were used, and it is very interesting to note that the results obtained were very favorable, and the experts there believe that the immature Eucalypts offer a good material for the establishment of a paper industry in Australia.

Turpentine investigations and some timber testing work have also been carried out successfully. The lack of a central laboratory to co-ordinate the work is, however, very marked; such scattered work has its value, but it leaves an enormous field untouched, and moreover necessitates a good deal of unnecessary overlap.

The Government of India long ago recognised the value of forest research, and established at Dehra Dun a splendid Forest Research Institute. The range of the work carried out here is greater than that in any other institution of its kind, and includes sylviculture and such branches of forestry. Attached to the Institute are two forestry schools for training forest rangers and provincial forest officers. So valuable have been the results that the Institute is now to be removed from the school, and is to devote its whole time to research. The buildings and equipment are to be enlarged and a larger staff engaged. A sum of £500,000 is being spent on this development, and several officers of the Institute have been sent abroad to gain experience of other places, to purchase equipment, and to obtain a staff for the new branches to be developed. The Institute has kept in touch with industries by means of liaison officers, and there is in consequence the closest co-operation. A splendid development has been the establishment of a Forest Utilization Circle at Bareilly under a special conservator. This Circle takes the results of the laboratory investigations and converts them to factory scale experiments. When these are successfully worked out the results are available for any industry. The turpentine factories have been a huge financial success, and to demonstrate the possibilities on a large scale the Government is now erecting a spacious factory, costing £120,000. Another result has been the establishment of a bobbin making industry to supply the Calcutta mills. Much research by the Institute preceded the development of this industry, which is now assured of success.

Timber preservation has occupied a large amount of time at Dehra Dun, and, among other interesting results, the efficacy of the Powellising process for preserving railway sleepers has been thoroughly demonstrated—for country where the rainfall is not very heavy. This is comforting when one considers the large number of Powellised Karri



WINDING STAIRWAY, STATE MUSEUM, SEATTLE.

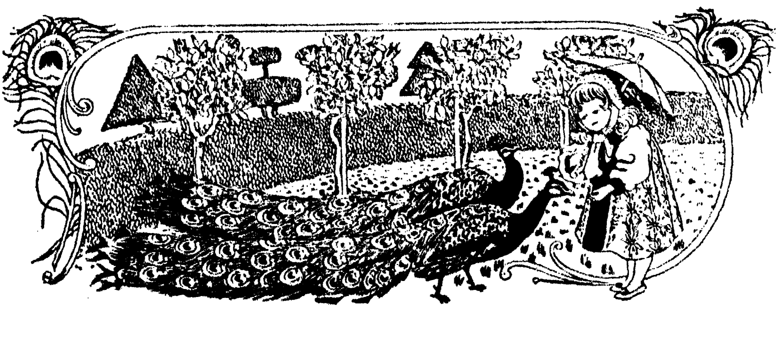
sleepers in the Trans-Continental railways. Another activity of the laboratory is the employment of a special tanning chemist in making a complete survey of the tanning resources of India. Immense benefit has followed the work of this officer.

Perhaps the most striking practical result of the laboratory investigations is the erection of four large paper mills to manufacture paper from bamboos. The preliminary experiments occupied several years, and much work had to be done in removing prejudices. This great success is due to the work of Mr. Ridtt, the paper expert of the laboratory.

The field of research into forest products has by no means been exhausted, and if Australia means to utilize to the best advantage such forests as remain to her, and to establish the large number of secondary industries depending upon the forests for raw materials, such research must be begun at once. Results cannot be obtained in weeks or months. In some cases years are needed. Already the waste of wealth through inefficient methods, or through lack of knowledge of possibilities, has been immense. The establishment of a properly equipped and staffed Forest Products Laboratory can do much to prevent this waste. No other method can prove as satisfactory as the co-ordination of all such research under one institution, and it is to be hoped that the establishment of this will be gone on with as soon as possible.

"The philosopher should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favourite hypothesis; be of no school; and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industiy, he may indeed hope to walk with the veil of the temple of Nature."

—FARADAY.



Suggestions for the Improvement of Native and Dairying Pastures.

By E. BREAKWELL, B.A., B.Sc.

At the present time fully two-thirds of Australia's wealth is obtained from the agricultural, pastoral, dairying, and allied industries. It seems practically assured that for many years, at least, this continent, by virtue of its excellent climatic and soil conditions, and large areas of tillable land hitherto undeveloped, must be essentially, the rapid development of secondary industries notwithstanding, a primary producing nation. The Prime Minister's slogan "Produce more" must therefore be made to apply to the primary, as well as to the manufacturing industries.

At the present time neither the pastoral nor the dairying industry is producing to its full capacity. It is the object of this article to show how production is being restricted, and to offer suggestions by which an increase can be obtained.

Australia has had a most valuable asset in her native grasses. These may be broadly divided into two classes, viz., those on the coast and those on the inner side of the mountainous escarpment facing the coast. The coastal native grasses have provided in the past, and still are providing in some localities, a large amount of the rich dairying pastures. Some examples are—Couch or Bermuda grass (*Cynodon dactylon*), Water Couch (*Paspalum distichum*), the Love grasses (*Eragrostis* species), and the Danthonia grasses (Wallaby or White Top species) In the early days, when the population was small and the dairying allotments large, these native grasses sufficed for the well-being of the dairying herd, maintaining a beast, say, to 3 acres. But under closer settlement and more intense cultivation, grasses which would have a greater carrying capacity, as much as one beast per acre on alluvial soil were eagerly sought after. In this manner there were introduced from Europe grasses like Cocksfoot, Timothy, and Rye, which are so common at the present time in Tasmania, Victoria, and, to a less extent, in New South Wales. These, however, were not considered in New South Wales all that was desirable, and a distinct fillip was given to the dairying industry by the advent of such quick-growing grasses as *Paspalum dilatatum* and Rhodes grass, and at the present time there are, perhaps, larger areas of these grasses than of any others in dairying districts.

Other grasses like Sudan grass, Elephant grass, and Phalaris bulbosa have now proved themselves to be of incalculable benefit under such conditions, and there appears no special reason why still better grasses than Paspalum, Rhodes, and others mentioned should not be discovered in the future by careful trial and investigation.

SUGGESTIONS FOR IMPROVEMENT OF PASTURES.

Progressive dairymen are continually on the search for new grasses and fodder plants which show an improvement on the old ones. Other dairymen, however, are content to rely on more conservative methods, and lose heavily when conditions are adverse. Some of the main factors which lead to a reduced dairy output are as follows:—

(1) Disinclination to lay down pastures with grasses which have undoubtedly proved to be superior to the older ones in similar localities.

(2) Neglect to grow winter feed.

(3) The absence of one or more paddocks of good drought resistant grasses, which are a distinct acquisition in dry periods.

(4) Neglect to conserve fodder.

(5) Injudicious management of pastures, particularly as regards rotation.

The various State Agricultural Departments have definitely proved that abundant winter feed can be provided for dairy stock by growing cereals, and that certain varieties will produce much better results than others. It has also been shown that a combination with winter legumes like vetches or peas provides a much better balanced ration than the cereal alone. The value of certain winter grasses like Tall Oat (*Avena elatior*), Giant Fescue (*Festuca arundinacea*), and Phalaris bulbosa has also been proved. It is to be regretted, however, that the growing of such winter feed is not taken up by dairy farmers as much as it should be, and, as a consequence, the milk production is considerably lessened.

Droughts occur throughout Australia at fairly regular periodic intervals, and during such periods hundreds of dairy stock perish, and the dairy output diminishes owing to lack of feed. A great deal could be done by dairymen in providing feed by growing crops of Sudan grass and Elephant grass, and also, to a less extent, by planting Sorghum.

Planters' Friend and Amber Cane Sorghum will endure a considerable amount of dry weather if cultivation is carried on between the rows of the growing crop. Sudan and Elephant grass, however, will stand even more dry weather than the Sorghums, and splendid cuts, on a rainfall of 4 inches, extending over six months, have been recorded. Even should the season prove normal and an excess of feed produced, this surplus could be well conserved either as hay or ensilage. The number of silos established in Australia is ridiculously small, in spite of the knowledge that such silos are of material benefit to those who use them.

Pastures appear to be well managed in every country except Australia. It is true that the climatic conditions here differ considerably from those in Europe and America, and that the pastures require characteristic treatment; but this characteristic treatment appears, in most cases, to allow the pastures to remain down indefinitely, to stock "up to the hilt" in good or bad seasons, at all times of the year, and to ignore such a principle as rotation. If pastures were rotated with lucerne or summer crops, like maize, every few years the increased amount of feed produced would surprise many a dairyman, and if more

attention were paid by having smaller paddocks, thus allowing the grasses to rest and seed at intervals, the pastures would carry a much bigger sole of grass than they are doing at present.

The pastoral and mixed farming industries of the interior are in an even worse condition of neglect than the dairying industry. The pastoralist and mixed farmer have, in addition, been the victims of circumstances unknown to the coastal dairyman. In the first place, the native grasses of the interior have been choked out in many places by introduced herbage such as Barley grass, Burr, Trefoils, and Brome grasses. With ordinary winter and spring season, similar to the spring and summer of the European countries from which these plants have been introduced, this herbage produces a large amount of succulent feed, and the mixed farmer and pastoralist are often under the delusion that such feed cannot be improved upon. But this herbage has two serious disadvantages—

(*a*) It is short lived, dying down in early summer, and in summer and autumn, therefore, the native grasses are badly needed. Owing to the aggressive character of the herbage, however, it has crowded out in most wheat-growing districts the original native grasses, and the sheep have, during the most critical period of the year, to subsist on burrs or any odd rubbish they can find.

(*b*) Under drought conditions, or even in fairly dry periods, the herbage entirely fails, and the farmer has then to resort to agistment or hand feeding.

Most striking examples of the inferiority of herbage country to native grass country have been evidenced during the past drought, and, as far as New South Wales is concerned, the writer is practically certain that losses in sheep on the slopes and tablelands have occurred where herbage pasture has been the rule, and not where native pastures have existed. Danthonia pastures in any part of New South Wales, where the water in the wells was ample, were carrying practically fat sheep up to December. Even in good years no evidence has yet been brought forward to show that good herbage country will carry more sheep all the year round than a native pasture containing Danthonia, Chloris, &c., will do.

The suppression of all herbage country is, of course, impracticable, nor would it be at all wise. Herbage grows very strongly in wheat-growing districts, and it is impossible to prevent the introduction altogether. What is strongly advocated, however, is the presence of one or more paddocks of native pastures, Danthonia and Chloris for preference, to provide feed during the critical period of the year, when the herbage and stubble are exhausted. It is an unwise policy for a mixed farmer, when running sheep in combination with wheat, to plough up all his native pasture land in order to grow wheat.

Again, most mixed farmers and pastoralists have not concerned themselves with the quality of the grasses on their estates, nor have they attempted in any way to maintain or improve good grasses which would thrive under the existing conditions. It is a remarkable fact that whereas the wheat farmer displays a keen interest in and knowledge of

the wheat crop, and is ready in most cases to adopt improved practices, a striking lack of knowledge is shown as regards the pastures. To many anything green is "grass," whether it be a quickly-spreading weed or one of the best of fodder plants. The lack of distinction nevertheless must result in the rapid progress of the more aggressive plant, which, in many cases, is the poorest of fodders. Thus the rapid spread of useless short-lived Brome grasses, Stink grass (*Eragrostis major*), and many others. Compare such a system with the treatment given by an intelligent and skilful pastoralist to his pastures. He carefully observes the essential characteristics of his grasses—their palatability, drought resistance, fattening qualities, &c.—and the good grasses he endeavours to increase in area by encouraging their seeding habits, and by distributing the seed over areas less fortunate in the possession of good varieties.

In the third place, insufficient attention is given to the matter of summer and autumn feed. Where herbage country is existent and native pastures absent, such summer and autumn feed become an absolute necessity. Excellent results have been produced in this connexion by Sudan grass, Rhodes grass, and Grain Sorghums. These will grow in the interior of most parts of Australia on an average rainfall as low as 15 inches. Sudan and Rhodes grass make excellent hay, or can be pastured, while the Grain Sorghums can be utilized for grain (the nutritive value of which is almost equal to maize), or for silage.

Conservation of fodder also deserves much more attention than it at present receives. Australians are temperamentally speculators, and although they sincerely regret, during a drought, that they did not conserve fodder when times were good, all is soon forgotten when conditions are again normal. The amount of native grass and herbage that goes to waste during good seasons would feed thousands of stock for a considerable period. Such fodder can economically be conserved in the form of hay or pit silage, as frequently explained by the various State Agricultural Departments.

In summing up the manner in which the native pastures of the interior can be improved and their carrying capacity increased, the following suggestions should be acted upon by the various State Governments, in addition to what has been already discussed:—

1. Farmers should receive full field instruction in the value of the best native grasses for various divisions. A great deal has already been written concerning our native grasses by various botanists, but to the pastoralist such information is valueless unless he can readily identify his grasses and is aware of their characteristics. A complete course of field lectures by various experts throughout different parts of the States would be of inestimable benefit. Co-operation with various pastoralist and farmers' associations would be necessary to carry this out thoroughly.

2. Tons of native grass seed should be on hand for distribution to farmers, at a very low cost. Owing to the fact that the areas are large and the germination of the seed low, pastoralists require an enormous amount of seed for scattering over their paddocks. It is remarkable that the seed of only two or three native grasses

is obtainable from seed merchants, and that at a prohibitive price (up to 8s. per lb). The seed of one of our best native grasses (Danthonia) is obtained from New Zealand, and harvested from varieties far inferior to our own. This native grass seed is available in any quantity during good seasons and only requires the facilities for harvesting it. A great deal could be gathered with the ordinary wheat harvester; some varieties would require binding, and to be flailed or stripped in some manner, while other varieties would then require hand stripping in the field. A mixture of a few good native grasses would serve the purpose as well as a single variety. There are many pastoralists who would, for a reasonable remuneration, lend their paddocks out for this purpose if the labour and machinery were provided. To be done quickly and effectively the areas at the various State experiment farms are not available, and all that can be done at these institutions is to prove the value of certain varieties, and harvest the seed in limited quantities.

In conclusion, it might be stated that Australia requires a much greater population in order to carry out thorough and intense cultivation. It is safe to say that over 50 per cent. of the dairying and other farming areas would support twice the population, and produce twice as much as at present under a system of intense culture. When the areas are large, weeds hold sway, pastures become neglected, crop rotation is ignored, and the farm presents an uncared-for appearance. In many cases the farmer has not the labour to remedy this state of things, and he simply endeavours to do the best he can to keep the farm going. If population and labour were available intense cultivation could become more practicable, weeds would disappear under constant ploughing and working the soil, pastures would be treated so as to produce to their full capacity, crop rotation would be practised, and principles of good farming brought into operation.

Power Alcohol: Its Position and Prospects.

By T. BAKER.*

As nearly two years have passed since the Power Alcohol Committee of the Advisory Council of Science and Industry published its proposals for the production and utilization of power-alcohol in Australia it will be interesting to consider how the matter stands at the present time.

At the time that the committee published its proposals the maintenance of the supply of liquid fuel in Australia was causing considerable anxiety, as not only was the limitation of shipping, due to the war, interfering with the regular course of trade, but there was grave danger of the supply being altogether cut off, and our defence measure thus, to a considerable extent, paralyzed. Although that critical stage has passed, the desirability of Australia being able to provide for its own liquid fuel requirements remains as great as ever, for the use of liquid fuel in motor transport and in aeroplane work is already so great, and is extending so rapidly, that the provision of an adequate supply at a reasonable price is a matter of the greatest national importance, and almost a necessity to civilized existence.

The imports for the last financial year of petrol, benzine, and kindred products (but excluding kerosene) amounted to more than 20,000,000 gallons, of which the invoice price at port of shipment averaged about 1s. 6½d. per gallon. Its total entry value (invoice, plus 10 per cent.) was £1,791,408; but this does not by any means represent the total cost to Australia, as freight amounted to far more than the added 10 per cent. A great proportion of the supply came from the United States of America, and, in order to pay for £1 worth of goods there, we have had, during the past year, to part with about 25s. worth of British currency. Altogether we may reckon that last year we had to remit some £2,300,000 to pay for our motor spirit. If alcohol made here could replace it, we would have that immense sum for application to other purposes.

The actual use of alcohol has been demonstrated to be quite practicable, even in the ordinary motor car engine, although not economical, and a large scale trial of it has been made in some of the London motor buses—of this trial the final reports are not yet to hand.

It has been proved that the moving parts of the engines are not at all injured by the fuel, but there is some tendency to corrosion in the silencer. Formerly, when using alcohol alone, there was considerable difficulty in starting the engine when cold, but means have been found of overcoming that difficulty. One method was worked out in the Sunshine Harvester Works, and in the course of some experiments carried on under the direction of the Power-Alcohol Committee at the Engineering School of the Melbourne University, it was found that if each of the cylinders of the engine is primed with about 5 cc. (a teaspoonful) of alcohol, the throttle closed, and the engine "cranked," ignition takes place. The liquid in the cylinders serves as a reserve, and suffices to

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turn the engine several times. As the throttle is opened, a supply of alcohol is taken up from the carburetter, and the engine continues to run. The *raison d'être* appears to be that when the engine is turned with the throttle closed, a partial vacuum is formed which induces rapid evaporation of the alcohol, and in a few turns the formation of a mixture sufficiently rich to ignite. It remains to be seen whether this method of starting will be practicable with heavy engines, but it has succeeded with most of the numerous makes which have been experimented with.

Another method of overcoming the starting difficulty is to convert a portion of the alcohol into ethylic ether. An alcohol-ether mixture containing about 30 per cent. of ether gives easier starting in cold weather than the ordinary grades of petrol, and has the advantage of giving a more concentrated fuel than alcohol, which contains only 10789 B.T.Us per pound, compared with petrol and ether, which contain 19162 and 15476 units respectively.

The calorific value of the respective fuel shown by these figures does not necessarily indicate that nearly two units of alcohol are required to do the same work as one unit of petrol, for alcohol will give greater engine efficiency; indeed, it has been claimed by experimenters that alcohol can be made to do about the same amount of work, weight for weight, as petrol. The experiments made at the Melbourne University for the committee have not altogether substantiated this claim. The increased efficiency of alcohol over petrol would also probably be obtained with the alcohol-ether mixture. The cost of converting the required proportion of the alcohol into ether is not very serious. I investigated the matter both in England and the United States of America, and reported to the Prime Minister in February, 1918, that where ether is made in large quantities, as was the case in England for the manufacture of explosives during the war, the cost of manufacture was slightly over £2 per ton, depreciation of plant and all overhead charges included.

A company was formed for carrying on commercially the manufacture of alcohol-ether motor fuel in South Africa, but I have not yet learned what results are being obtained either in the manufacture or use thereof, but definite information should now be available.

The foregoing will show that there are no technical difficulties in the way of using alcohol, but, unfortunately, when it comes to the commercial aspect the outlook is not encouraging.

In the report to the Prime Minister, previously referred to, I made use of the following words:—"While alcohol is produced synthetically from acetylene—and some from refuse liquors arising from the manufacture of sulphite wood pulp, and still more from saw-mill waste—it is safe to say that at least 99 per cent. of the world's alcohol supply still comes from various farm, plantation, and fruit crops. Upon the price, therefore, at which the farmer can give us those crops, it at present depends whether it will be practicable to use alcohol instead of petrol as an engine fuel." The position is still the same, although in Norway and some other countries in which sulphite wood pulp is largely produced, the manufacture of alcohol from the refuse liquors has assumed large proportions. Some progress has also been made in its synthetic production, the new source being ethylene, extracted from coal gas. The process is considered very promising, though details as to cost are not yet available.

The value of any field crop for the production of alcohol is dependent upon the proportion of starch and sugar which it contains. Starch and sugar are indispensable elements of the food of man, both directly and indirectly, in the shape of animal foodstuffs. It has been rather aptly stated that alcohol is a parasite on the food supply, and if that is the case when the comparatively limited quantity required for potation is under consideration, the effect might well be very serious if for any reason alcohol had to be relied upon to replace any considerable proportion of the world's supply of petrol. That aspect may, however, be neglected in favour of the more practical consideration of cost.

Grain crops are the principal raw material for the production of alcohol at the present time. In the United States of America no less than seven-ninths of the alcohol produced is made from maize, and most of the remainder from molasses. In Germany, potatoes are principally used; in France, beetroots. The quantity of alcohol that any material will produce may be very easily calculated if the starchy or saccharine contents are known. While theoretically 169 imperial gallons of 95 per cent. alcohol (the strongest that can be obtained by distillation, and the strength most suitable for engine use) should be obtained from a ton of starch, and 159 gallons from a ton of sugar, the actual yield is only from 85 to 90 per cent. of that quantity. The number of imperial gallons that any material will actually yield per ton may be ascertained approximately by multiplying the percentage of starch and sugar contained in it by 1.43. Most grains contain about 65 per cent. of starch, and will yield at the rate of about 93 gallons per ton, or 2.5 gallons per bushel.

Potatoes, according to their starch contents, will yield from 22 to 29 gallons per ton. These figures give a basis for calculating the cost of alcohol, as far as the principal raw materials are concerned.

It is very certain that if any great quantity of alcohol is to be produced here, the only material which will be available without special cultivation is wheat, for the reason that it is very widely grown, and may be preserved indefinitely in good condition without greater care than dryness and protection from rats, mice, and insect pests, while all root crops are available for a short portion of the year only, and, after maturity, rapidly deteriorate, even when carefully stored. The same applies to fruits. Moreover, the cultivation of root and fruit crops involve greater cost for the quantity of starch and sugars produced.

In all probability the price which has been current for some time past for wheat may be looked upon as the lowest that is likely to rule here for a very considerable time to come, viz., 5s. 6d. per bushel. That price is much lower than the world's parity has been. Producers are naturally not very well content to have to sell their produce, even for food purposes, at a lower price locally than they could obtain from others, and they probably would most strenuously oppose being compelled to subsidise in a similar way users of liquid fuel.

Take, however, the price of wheat at 5s. 6d. per bushel. Wheat contains about 65 per cent. of starch, and will yield about 93 imperial gallons of alcohol per ton. This gives 2.2 shillings as the cost of one gallon of alcohol for wheat alone. Making will cost at least 4d., even for production on a large scale. Denaturing will cost 3d., at the least, making the total cost, without anything for deterioration of plant or other overhead charges, or profit, 2.78 shillings per gallon.

Petrol is now sold in bulk at 2s. 11d. per gallon, so it would not be practicable to produce alcohol from wheat at 5s. 6d. per bushel to sell even at the same price as petrol; and, on account of its inferior thermal value, alcohol is worth considerably less than petrol for use in the regular engines, or any engine in sight.

In the above figures no credit has been taken for the value of the different by-products of alcohol production from grain. If provision were made for the recovery of their full value, the cost of alcohol might be considerably reduced. In a great distillery in America which I visited, 16,500 bushels of maize are used daily for distillation. The first process is to extract the germ, from which an edible oil, worth almost as much as olive oil, is pressed, the yield being about 2 per cent. of the weight of the maize. The maize is then crushed, mashed and fermented, and distilled, and the spent wash treated in filter presses to extract the solid portion. The liquid from the filter press is treated in special type evaporators, and so reduced to a treacly fluid. This is mixed with the solid residue from the filter presses, and further dried. The resulting product somewhat resembles crushed oats in appearance, and is used as a cattle food, selling at a somewhat higher price per ton than the maize from which it is derived. The residual oilcake from the expression of the oil is also worth more per ton than the maize. In this establishment, in an immense shed, 10,000 cattle were being fattened, the main food being the liquid residue from the stills, with some hay. The fusel oil also is a source of considerable revenue.

From potatoes there is little prospect of alcohol being economically produced here, as the average market price, over a series of normal years, will show. This price was, for the five years ending 1915, 85s. per ton, at which price the cost of alcohol, for potatoes alone, would be 3s. per gallon. Of course, the selling price on the farms is much lower, but not sufficiently so to make potatoes a practicable raw material for the manufacture. It is well known that in Germany, the great alcohol-producing country of the world, potatoes are practically the only raw material used, but they were sold there at about 20s. to 27s. per ton before the war, the growers receiving a considerable subsidy from the Government, this subsidy being provided from the duty collected on alcohol. When our farmers are prepared to let us have potatoes at that price, the cheap alcohol problem will be pretty well solved, as the raw material cost would then be 8d. to 10d. per gallon. Besides this low cost, the refuse from the stills is used for the stall feeding of cattle, which, in Germany, are stalled in winter, and the distillation of the tubers is carried on during that season.

The special attention of our agriculturists is directed to the fact that in Germany and England statistics show that the average yield of potatoes is in excess of 200 bushels per acre, and the starch contents 22 per cent. Our statistics give the yield at 108 bushels, and the starch is said to be only 16 per cent. Attention might also be given to the potato planting and digging machines in use in the United States of America. I was informed by the Department of Agriculture in Washington that one of those digging machines will dig a load of potatoes in twenty minutes, and harvest 4 to 6 acres a day, the picking up being

so perfectly done that fewer potatoes are left than when the digging is done by hand. Not being an agriculturist, I mention these matters with some diffidence.

The position as regards molasses, a by-product of sugar manufacture, appears not to have greatly changed since the publication of the report of the Power-Alcohol Committee in 1918; that is, that the greater part of the molasses produced in Australia is still being allowed to run to waste. In Cuba, in 1917, it was worth 7½d. per gallon for shipment to the United States, where it is used for the manufacture of alcohol. As it costs 35s. per ton to transport to its destination, its value in the United States of America was about £7 per ton, and the price is steadily rising, as its value for cattle food is being more widely appreciated. At its present price there, it is no cheaper for the manufacture of alcohol than is maize. In the committee's report its value is stated as being about 25s. to 30s. per ton. It seems remarkable that so large a quantity of a valuable produce should continue to be allowed to run to waste, especially as there is in the Commonwealth such a famine in methylated spirit that many industries are severely handicapped.

In the committee's report many vegetable products are mentioned as probably suited for cheap raw materials for the production of alcohol. Unfortunately, these are still only suggestions, as little or nothing has been done in the way of making practical tests. I think it doubtful whether any of the crops mentioned will be used, to any great extent, for the manufacture of alcohol, for the simple reason that they woud have a higher value for food purposes, and would, therefore, be used as food, or for other purposes for which starches and saccharine materials are more valuable than raw materials for the production of alcohol.

There remains yet another source of alcohol to which some consideration may be given, and that is saw-mill waste; its production from that base has attracted much attention, and the process in use has been known for many years, yet there were in 1917 only two establishments in the United States in which it is used, and in those two establishments an immense amount of money has been sunk.

The figures given as being the cost of production are remarkably low, yet I believe that they are perfectly correct. Possibly the prohibition campaign may have had something to do with the non-expansive condition of the industry, as the very great technical difficulties incident to the process had only just been overcome when I had the opportunity of visiting one of the distilleries using mill waste in 1917. The process can only be worked under special conditions, one of which is that the waste must be available at a very low cost, and in very large quantities. Softwood only is considered suitable, as the yield from hardwood is said to be too low to pay. Sawdust proved to be unsuitable, as there was difficulty in extracting the saccharine matter after it had been formed by treatment with acid. Hogged wood, or chips from planing machines, is used. These are subjected to a mechanical crushing process, by which the grain is opened up, then put into rotary converters, which are strong iron cells lined with acid-proof bricks, jointed by a special cement. Each converter takes about seven cords of wood. The wood contains nearly 50 per cent. of moisture, so the charge is equal to about 4 tons of

dry wood. When the converters are filled, they are closed, and diluted sulphuric acid added. They are subjected to steam pressure of 140 lbs. The conversion takes place very rapidly, the filling and emptying and treatment of each converter charge taking only forty-five minutes. The condensed steam and acid liquor is drawn off and taken to neutralizing vats, while the treated wood is conveyed to diffusers, of which there are several, and subjected to treatment by water, by which most of the sugar is extracted. Liquor is neutralized with lime, and then mixed with a special culture of yeast, and fermented in the usual way. I learnt that there is a considerable quantity of sugar carried away in chips, which are subjected to a rinsing wash, after they come from the converter, to free them, as far as possible, from the acid liquid, then passed through a continuous press, which extracts most of the moisture from them, and then dumped in heaps. After being exposed to the atmosphere for a short time, they are dry enough to burn under the boilers in the usual way.

In this particular mill the wood waste is charged at a very low price. I think it improbable that wood could be specially cut and treated in this way for alcohol to compete with alcohol from other sources.

Next in importance to the cheap production of alcohol comes the question of its denaturation, or rendering it unfit for human consumption. The denaturant must be cheap, or it will add too much to the cost; nauseous, so that it will deter even the hard drinker from relishing it; and of such a nature that it cannot be separated by simple distillation, or any other operation which can be carried out without special skill and knowledge. The denaturant now most relied upon is methyl alcohol, or wood spirit, obtained by the destructive distillation of wood. Other substances are added. The wood spirit is in every way suitable, but it has the serious drawback of being scarce and dear, and is badly wanted for the production of other chemicals. Substitutes have been proposed, but they appear to be inacceptable to those who are responsible for the protection of the revenue, so large a proportion of which is derived from potable alcohol. There is reason for caution in this matter, as the duty payable on potable alcohol is nearly 70s. per gallon, and power-alcohol would have to be sold at about 2s. 6d. per gallon.

It is certain that there would be great danger of the revenue suffering if power-alcohol could be readily obtained, unless it were denatured in such a way that it would be practically impossible to produce a palatable beverage from it. As a preparatory step for the era of alcohol fuel, the Government should offer a handsome reward for the discovery of a suitable cheap denaturant.

From the foregoing it will be seen that there is little prospect of alcohol being produced at a price which will compete with petrol, even at the present high price of the latter, unless the Government is prepared, as a matter of public policy, to offer a bonus for its production. Any such bonus would have to continue indefinitely, unless a fall in value of cereals, unaccompanied by a corresponding decrease in the value of petrol, should take place.

The Glass Industry.

By EWEN MACKINNON, B.A., B.Sc.

Glass making has been included in the list of key industries by the British Government. In his speech on August 18, 1919, when moving the adjournment of the House of Commons, the Prime Minister referred to the necessity for shielding "unstable key industries." What is meant by a key industry and what is the cause of instability in the glass trade? To answer the first part of the question there are four tests that have been applied as follows:—

(1) Was the industry found to be essential for war purposes or for the maintenance of the country during the war?

(2) Was it discovered, during the war, that the industry in question had been so neglected that there were not sufficient goods produced to supply the essential war requirements?

(3) Was it found necessary for the Government to take special steps to assist and foster that industry during the war?

(4) If the special Government support were withdrawn, could the industry maintain itself at the level of production which the war needs have shown to be essential to the national life?

To be termed a key industry would require answers in the affirmative to questions one, two, and three, and the answer to four would partly indicate the amount of instability, as a stabilized trade would quickly return to normal pre-war conditions, and only a key industry would be likely to need the continuance of the Government support. The key industry in the present question includes the following sections in particular of the glass industry: Optical glasses (including lenses), prisms and like optical devices, scientific and optical instruments, scientific glassware, illuminating glassware, laboratory ware, and potassium compounds. To assist in stabilizing the industry the Board of Trade will prohibit the importation of foreign goods except on licence.

The glass industry in itself is not of very great magnitude, and it comes as a revelation to most people to know that it is, in some of its aspects, of such vital importance. (There are now about 400 firms engaged in glassware manufacture in Great Britain, and the employees number about 50,000.) Another industry of a key character, and now more generally known, is the dye industry, which controls indirectly much of the work and wages in the textile industries. Early in the war we knew of the urgent need for optical glasses for officers of the Australian Imperial Force, but probably few people in Australia knew of such things as the following:—(1) The urgent requests from the steel works at Sheffield, Leeds, Manchester, and other places for suitable supplies of chemical glassware to carry on their important work for war purposes. (2) The supply of miners' lamp glasses, to enable the miners to keep up the supply of coal for the Navy, for factories, for the Allies, &c.; so serious was the need that the Government had to relax the restrictions against German glasses, and also to modify the mining regulations, to overcome the difficulties. (3) The need of sights for guns of

all kinds, of range-finders, of light projection apparatus, signalling apparatus, and many other optical arrangements. (4) The great need of suitable sheet and plate glass for goggles and gas masks for airmen and soldiers, wind screens for aeroplanes and cars, plates for photographic work, X-ray apparatus, glass tables for operations, and non-actinic and coloured glass of all kinds for special work. (5) The enormous demand for ordinary glass bottles, jars, and food containers, not only for foods, but also for medical supplies and chemicals, &c.

These are a few of the urgent demands on certain sections of the glass trade, which the general public may not have considered and which justified the industry being classed as a key industry, as the Government had to foster and support many of the factories, when converted to new purposes, and the industry as a whole was placed under Government control.

Let us now look into the general conditions of the glass industry and the developments during the war period. In the first place, the majority of the British manufacturers had not kept pace with developments in the glass industry on the Continent. Many had ideas that they possessed trade secrets, and they were opposed to any suggestions of scientific training for the workers or the alteration of their methods, based on tradition and custom, to methods evolved by scientific investigation. The furnaces in use were generally out of date, but were considered good enough for the purpose. They were, as a rule, circular coal-fired pot furnaces for the better class of glass, and were capable of heating 12 pots about 38 inches in diameter. Each pot held about 15 cwt. of metal, so that 7 to 8 tons of glass were manufactured in a week (only one batch was the custom), with a fuel consumption of 40 tons. The chief advance that had been made on this furnace was in the nature of the firing. In the English furnace the leaking of a pot would result in the formation of great masses of clinker, clogging up the grate, reducing the general efficiency of the whole furnace, and often necessitating the digging out of the offending pot. In the new type, the coal was first converted into gas away from the glass furnace, which became much cleaner, and, on the Continent, was far better lighted. Although coal gas was first used, in America natural gas was also largely used, and these were replaced in Europe and America by producer gas, and the air used for mixing for the combustion, was preheated by the waste heat from the furnace gases.

The two best-known types are probably the Siemens regenerative and the Hermansen recuperative furnaces.

Without going into details, it will be sufficient to state that in the Siemens regenerative type the incoming air can be drawn in at either end alternately, passing through a heating chamber by a system of fire-brick channels, and is thus heated before mixing with the gaseous fuel. The direction of the gases in combustion which play over the pots is reversed, by a system of flues, about every half-hour. The waste gases, before reaching the chimney, pass through either chamber alternately at the ends of the furnace, and thus supply heat, which is used to heat the incoming air. When the batch is melted either regenerator may be cut out and straight draught and lower heat (no preheating of gases for combustion) may be used, until the batch is worked out. The main

advantages over the English furnace are: The furnaces are smaller and give a much higher temperature, with less fuel consumption, greater ease in regulation, cleaner conditions, and no clinkering of fuel when a pot leaks. The batch is melted at night, and within 24 hours a new batch is ready.

A 10-pot furnace, taking pots about 30 inches diameter, holding 5½ cwt., will turn out 15 to 18 tons a week, consuming about 18 tons of fuel. The building cost varies from £1,600 to £2,000.

The great disadvantage is that on reversing the direction of the burning gases the greatest heat is brought suddenly on to the cooler pots, and the sudden fluctuations in temperature considerably shorten the life of the pot by causing it to crack. A pot is an expensive article, often costing about £10 by the time it is in position in the furnace.

In the Hermansen recuperative type, by an arrangement of fireclay tubes the waste gases drawn off through the chimney first pass through a series of horizontal flues which surround the channels by which the air is drawn into the combustion chamber. Here the incoming air is preheated ready for combustion with the producer gas, and the regulation of the furnace heat becomes a simple matter of controlling the draught by means of the dampers provided in the main flue. No reversing of the direction of the draught takes place, and a more even temperature is thus maintained throughout. The batch varies from 5 to 12 cwts. per pot, according to the size of the furnace—4, 6, or 8 pots —and is melted nightly. About 20 tons of metal are produced with a fuel consumption of 16 tons. The initial cost varies from £800 to £1,200.

The Tank Furnace.—The commoner and cheaper types of glass are melted in a tank furnace. This consists of a somewhat rectangular shaped compartment 18 inches to 24 inches deep, whose bed and walls are constructed of specially selected fireclay blocks, and varies in length from 30 to 100 feet. The mixed materials of the batch are introduced at one end at intervals as it melts down, and are worked towards the opposite end, where the molten metal is withdrawn through the openings provided for the glass-blowers.

Across the chamber, half-way along, is placed a bridge, with its edge almost level with the surface of the metal and serving to keep back all unmolten material and skum, thus keeping the metal for working much cleaner. The melting and the working are continuous. The capacity varies, but some give as much as 300 tons a week. Tank furnaces are simple, and melt glass economically, but the metal produced is not of such quality as that from pots. With improved methods of firing, the tank may be used in the future for plate and window glass making, on account of the quantity it holds. This is the common type of furnace found in Australia. The Hermansen furnace was first introduced into Scandinavia when the industry was so hard pressed by German productions. It is continuous in action, one running there for two years, melting 3 tons of soda glass per 24 hours. The temperature can be quickly raised to over 1,400°C.

As optical glass, resistant glass, and various other types are made by melting the batch at high temperatures, most of the English furnaces were incapable of producing these, and in many directions we were

almost entirely dependent upon foreign supplies. It is true that one English firm—Messrs. Chance Bros., of Birmingham, had successfully produced optical glass since its introduction. This firm supplied about 10 per cent. of the pre-war requirements, while the balance came from France (30 per cent.) and Germany (60 per cent.). At the factory of Duroglass Ltd., London, two new Hermansen furnaces have been erected, and, with other furnaces and equipment, many kinds of chemical and resistant glassware are being produced. Such success has also been achieved by Chance Bros., that the output of optical glass is now in excess of what can be absorbed under favorable conditions. Many of our gun-sights were exclusively German, *e.g.*, dial-sight No. 7 (C. P. Goerz, Berlin). This has now been replaced by sights made by Ross Bros. and by Beck, the two firms producing over 20,000 to date, making as many as 250 a week. In a similar way, Aldis Bros. introduced a sight for aeroplane guns in 1916, and now 20,000 have been supplied. Both members of the firm are University graduates ("Wranglers"), and amongst their achievements are the designing of all the electrical projection apparatus used in the Navy, and the 36-inch focus lens (6½ inches in diameter), used in such aerophoto work as that at Zeebrugge from over three miles high. Such has been the success in the production of chemical and scientific glassware that the annual output is now valued at £600,000, and is still increasing. Before the war it was practically nil.

In one field of research there must be co-operation between the glass and pottery manufacturers. Much of the success of the glass maker depends upon the quality of his melting pots. They must resist the corrosive action of the raw and molten material and the intensive heat of the furnace. Only the finest and purest of clays can be used in their preparation. Any impurities, such as small percentage of iron, may injuriously affect the colour or other properties of the metal. The urgent need on the part of the Optical Department of the Munitions Minister led to the formation of the Osmosis Company, to carry out the preparation of an extremely fine and pure clay by an electrolytic method. The process was the result of at least two years' experimental work, based on the discoveries of Count Schwerin. Just prior to the war the German company was about to introduce their process into England. The English methods, which represent a considerable advance on the pre-war German treatment, render possible the recovery of a clay substance in a comparatively dry state which has an increased plasticity, which sinters at a temperature which might be even 300° lower than that of the clay before treatment, which shows a greater contraction and has always a higher melting point. The practical application of this process must have an important bearing on both the pottery and glass industries.

Numerous other researches have been initiated in connexion with the corrosion of pots, the temperature for burning, the effect of variations in temperature—especially the melting point of the batch and the unequal melting of its constituents. This has led to further work in pyrometry—using all kinds of instruments—direct reading optical, recording, and radiation pyrometers. This is most important work, as a change of even 50° in a temperature of 1,000° to 1,400° may cause serious trouble. The temperatures must be as accurately determined as

possible and variation reduced to a minimum, *e.g.*, temperature for cessation of stirring: Light flint glass, 925°C.; medium flint, 950°C.; light crown, 1,150°C.

The microscopical and X-ray examination of glass and small pots have been initiated, and the electrically-heated experimental furnace has been introduced, as the temperature can be more readily controlled. Even some of the injurious gases used in the war have been turned to industrial use, *e.g.*, chlorine, perfectly dry, is delivered into the heated pots during the burning stage. It combines with the iron, which is thus converted to a compound that volatilizes. About 7½ lbs. of chlorine from the cylinder of the liquefied gas is used, at a cost of about 6s. per pot. Phosgene (carbonyl chloride) is also used in the Geophysical Laboratory of the Carnegie Institution for bleaching the sand, for optical lenses and eye-glasses. It also combines with the iron present as impurities.

All these investigations show the remarkable and rapid advances that have been made since the beginning of the war. But what is the stability of the industry from a commercial point of view?

Many of the British developments have been at the expense of some other branch of the industry. The alterations and extensions have frequently been hurried, and not co-ordinated. The best was made of all sorts of factories, and the work was done. These factories cannot now be expected to compete on equal terms with German and Austrian, which have not suffered in any way like those of France and Belgium. An example of this is the deliberate destruction of the great mirror factories at St. Gobain. This is stated to have been most systematically destroyed by dynamite. Moreover, the Germans and Austrians are perfectly organized for this work, well equipped, and have a large experience behind them.

In the matter of research in all branches of the glassware industry there are great hopes for the future, as so many associations are now showing active sympathy and support of such scientific investigation. The first work was initiated by the Institute of Chemistry, and this was later supported and encouraged by the Munitions Department, which now has an Optical Munitions and Glassware Supply Branch. Many glasses of foreign origin were carefully examined, and very many experimental batches were made, and finally a number of formulæ covering most of the desired kinds of glass were supplied by the Institute to manufacturers, each of whom, as a rule, was concentrating on one or two kinds of glass only. In 1915 the University of Sheffield founded a department of glass technology, in charge of Dr. W. E. S. Turner. This department was managed by a committee, consisting of members of the University, certain glass manufacturers, and labour representatives. Two Yorkshire Manufacturers' Associations—Glass Bottle and Flint Glass—each contributed £1,000 towards building a small model glass factory. Next the Department of Scientific and Industrial Research, which controls £1,000,000, set aside by the Government to be devoted to encouraging scientific research throughout the British Empire, granted £1,500 towards the equipment of the new department and also agreed to contribute £1,200 a year for five years. The glassware branch of the Munitions Department then granted £3,000 so that the plant could be

erected on a semi-commercial scale. In 1916, the Association of Bottle Manufacturers of Great Britain contributed £1,000, and agreed to contribute £250 per annum towards the upkeep of the department. Various other contributions were received, and the original committee was extended still further and became the Delegacy for Glass Research. The Department of Glass Research at the University guaranteed to spend £20,000 a year for five years, provided the Glass Research Association raised £5,000 a year over the same period. On the formation of the British Scientific Instrument Research Association, at first mainly for optical instruments, but later for various other scientific instruments of precision, a similar scheme providing for an expenditure of £40,000 a year for five years, and later extended by an additional £24,000 to £30,000, was adopted on condition that the members of the Instrument Association made an immediate contribution of approximately £7,000 out of their net revenue account. This association works in conjunction with the Department of Technical Optics at the Imperial College of Science and Technology, which is also assisted by the Industrial and Scientific Research Association as well as the National Physics Laboratory, which has undertaken the testing and standardization of chemical glassware of the highest grade. The test of clinical thermometers now reach 30,000 a week. It is interesting to note here that we can now obtain an English-made thermometer which will withstand very high temperatures (500°C.), and which is also provided with a white enamel back. This instrument is a great advance on any German instrument tested at the laboratory. It would thus appear that, with well-established places for research, directed by well-qualified investigators, such sections as optical and scientific glassware in particular will successfully hold their own with the foreign. They will have to stand the keen competition of Jena, which has an established world-wide reputation. Moreover, the United States of America, which before the war imported its optical glassware, has also made herself independent. Research in England during the war was directed mainly towards the production of goods previously imported from enemy countries. While there has been undoubted success in many different directions, any scheme devised for safeguarding the industry can only be effective if the industry strain every effort to attain to the highest pitch of efficiency. Real progress will be made only by the co-operation of manufacturers, workers, and users. The old style of coal-fired furnaces will be a handicap in the competition with the various new types, such as those fitted with automatic self-stoking producer plants. In the bottle trade some of the Owens machines are being introduced. These are capable of turning out 75,000 quart bottles in 24 hours. Other blowing machines will produce 30 large-size tumblers or 40/60 "nappies" per minute.

There has been a notable achievement in the making of electric light bulbs. The pre-war production was about 12,000,000 per year. Now it is 50,000,000, and one manufacturer can produce 400,000 a week. Great Britain can now supply all her own needs.

Automatic machinery for the production of bottles, tumblers, chimneys, electric light bulbs, sheet glass and tubes are now in operation. One of the greatest handicaps, compared with America, is the cost of fuel. In the United States of America coal can be obtained for £1 to £1 5s. a ton, while in England the cost rose from 14s. a ton to

£1 17s. a ton for the same quality, and coke from 12s. 6d. to £2 7s. 6d. a ton, from June, 1914, to November, 1918. The cost of fuel has risen about 100 per cent., and as the old style of furnace is very uneconomical the extra costs are a very great handicap. Raw material has also risen about 100 per cent., on an average, *e.g.*, good common sand from 6s. to 10s. a cubic yard; best French sand, 21s. to 44s. a ton; potash, 35s. a cwt. (June, 1914) to £12 10s. a cwt. (November, 1918); saltpetre, £26 a ton to £64 a ton; soda ash, £3 16s. to £6 6s.; and red lead, £23 to £56 a ton. In addition to the great increases in the costs of raw material and the doubling of wages since the beginning of the war, Britain has to face the restrictions of markets owing to the developments abroad. Other countries have been compelled to develop the glass industry to supply their own needs, and the United States of America and Japan have become keen competitors in the world's markets. Other countries like Canada, India, and Argentina have also developed the glass industry.

Although the industry was fairly prosperous in Japan before the war, only the smaller articles, such as lamps, bottles, tableware, flower vases, &c., were manufactured. Very little plate glass was made, owing to difficulties of manufacture. Practically all her window glass was imported. Now she supplies all her own requirements, and exports to the value of £350,000. Her other exports amount to £1,500,000 a year. The production of optical glass has been especially successful, and binoculars are now manufactured. Such countries opening up a new industry have the advantage of installing the most efficient types of furnace and all automatic machinery. The number of tank furnaces increased from 68 in 1915 to 106 in 1916, but fell to 88 in 1917. In addition, in 1917 there were in use 94 gas-fired pot furnaces (366 pots) and 663 direct-firing pot furnaces (2,230 pots, an increase of 641 on 1915). The total number of factories increased from 459 in 1913, employing 8,870 workers (430 females), to 822 in 1917, employing 17,700 workers (2,100 females). The total value of glass products was £785,000 in 1914 (glass bottles £300,000) and £2,736,000 in 1917 (glass bottles £875,000, lighting apparatus £262,000), and the value of the exports increased from £291,000 in 1914 (bottles £115,000, mirrors £57,000) to £1,448,000 in 1917 (window glass £311,000, bottles £440,000, mirrors £148,000), and £1,608,000 in 1918 (window glass £351,000, bottles £384,000, mirrors £200,000).

Japan has certain advantages in possessing abundant cheap labour, coal, and sodium silicate. She had, however, to import from the United States of America large quantities of soda ash and caustic soda (1913, £131,000; 1916, £293,000), and most of her machinery. In 1917 wages were 1s. 7d. a day for males and 8½d. for females over 15 years of age (73 per cent. and 8 per cent. respectively of total), and 7d. for males under 15 years (18 per cent. of total). Some of the factories are well equipped, all machinery being electrically driven; and the Asahi Glass Company (Mitsubishi), *e.g.*, has an output of 100,000,000 square feet of window glass a year. Although much of the early war period glassware was very irregular and badly annealed, the colour was good, and the Government is endeavouring to maintain the export trade which they have already procured. Regulations have been issued designed to maintain a high standard, which all exported ware must pass, and the packages must bear the certification mark. Australia has had experience of Japanese

glassware, but the improvement in quality in the local market has been noticeable, and Japanese goods are finding an increasing market in the United States of America (1915, £4,000; 1916, £8,000; 1917, £18,000; 1918, £65,000).

Of the glass and china imported to Australia in 1918, the total value was £782,000, of which 43 per cent. (£334,000) came from Japan, 23 per cent. from the United States of America (£182,000), and 30 per cent. from Great Britain (£235,000). The total value of British exports was as follows:—

	1915.	1916.	1917.
	£	£	£
To foreign countries ..	438,000 ..	454,000 ..	506,000
To British possessions ..	806,000 ..	850,000 ..	680,000
Totals	1,244,000 ..	1,304,000 ..	1,186,000

The total exports from the United States of America were £2,600,000 in 1917, and £3,094,000 in 1918; and the imports fell from £387,000 in 1917, to £270,000 in 1918.

Canada now manufactures as many as 35,000 electric light bulbs a day—sufficient to supply all her own needs. These cover all styles, carbon, tungsten, and nitrogen-filled lamps, ranging from 2 to 1,000 candle-power. Before the war there was only one factory in Canada—at Toronto. In the glass bottle trade 85 per cent. of the local production is by machinery and 250 to 300 gross of bottles are being made daily. Notwithstanding this, the imports of carboys, bottles, decanters, flasks, jars, and phials increased from approximately £500,000 in 1916 to over £800,000 in 1918.

In India the Government intends appointing a specialist in glass technology, whose services will be available for the whole country. At the beginning of the war they brought out a glass expert to supervise their investigations during the last four years. Scholarships in glass making are to be awarded for 1920, and the students are to be trained in the United States or Japan.

What is the situation in Australia to-day? It is stated that we have good sand; our fuel supply is good; and most of the raw materials are available, *e.g.*, lime, lead compounds, soda compounds, &c. We lack sufficient quantities of potash.

The number of employees was 1,800 in 1913 and 2,028 in 1916; and the corresponding value of output was £314,000 and £501,000. Our importations of glassware approximate £500,000 a year, so that the annual value of the industry is £1,000,000. In 1913 the imports were £625,000, but only £433,000 in 1917-18. In 1916-17 we imported glass bottles to the value of £50,000 from Japan, and our average annual importation from all countries is £75,000 (£107,000 in 1913). How comes it, then, that we can manufacture only half our requirements in bottles, not to say anything about supplying all our other requirements? There is a great opportunity for applying the results of British research to local conditions and introducing up-to-date furnaces, thus helping to make Australia as independent as other countries will be.

Notes on the Rhineland Chemical Works.*

By J. ALLAN.

PART 1.—MAIN FACTORS IN THE DEVELOPMENT OF THE GERMAN CHEMICAL INDUSTRY.

The time is opportune for us to take stock of our position in the world of chemical manufacture, and an important factor in determining our status must necessarily be the value which we place upon the German chemical industry, the heart of which undoubtedly is located in the valley of the Rhine. Much has been written, and even more said, of the greatness of the chemical works in this area and of the marvellous efficiency of their management. It has never been an attribute of the Germans to belittle themselves or their possessions, and many of the statements made as to the marvels of the country, of the wonders of its factories, and the ability of its people are their own assertions, varied merely by the language in which they are expressed. I do not wish it to be assumed from this statement that there is nothing great in what they have done in the business of applied chemistry, far from it, but I desire to assert that they have no monopoly in the ability necessary to initiate such enterprises and bring them to fruition. Many circumstances have contributed to the enviable position which they now hold in the domain of applied organic chemistry, and we can learn much from a full consideration of some of them, especially with the greater knowledge which has been acquired and the new perspective which has been created by the many happenings of the past five years. Not the least important of these has been the occupation of the Rhineland areas by the Allied forces, and their presence has made it possible for a survey to be made of practically all of the works within the occupied region under conditions which never previously occurred, and in a small measure to penetrate the wall of secrecy which has for long surrounded them. It is with the view of conveying to you some impressions of a visit to the occupied areas that the subject of this address has been chosen.

The present position of the German chemical industry is the outcome of a variety of causes, and not the least of these is the peculiar combination of natural advantages which arise from the possession by Germany of the Rhine valley and those of its tributary streams. Along the 200 miles of its navigable length in German territory, the greatest of its chemical works are situated. The river provides at once a means of transport for raw and finished products, both internal and seaborne, a supply of water for all kinds of technical operations, and a ready means of disposing of effluent; whilst in close proximity to the water front are to be found the great beds of brown coal, which supply fuel at a cost which is almost nominal. The supply of this cheap fuel is only one of the natural resources of this favoured part of Germany, since coal, lime, salt, and pyrites are all available within the transport area. These

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are natural assets, and they have been greatly added to by a network of broad and narrow-gauge railways which have been laid down wherever there is need, and which are operated under conditions which make their use peculiarly favorable to manufacturers within the districts which they serve.

The mere possession of such facilities, however, does not make an industry, and a glance at the story of the growth of their chemical industry will indicate at once that this is so. The manufacture of the so-called heavy chemicals is the oldest branch of applied chemistry, and in this Britain has for a long time taken a leading place. As a "large" industry, both in the home trade and for export, alkali and acid manufacture and the production of articles of trade in which these substances are employed had been in British hands for many years before Germany became a manufacturing nation. It was natural that the development of chemical manufacture in Germany should be along the line of least resistance offered by the field of organic chemistry, a line indicated by Perkins' discovery of aniline-purple or mauve, in 1856, followed by the production of aniline-red or magenta, by Vergius in 1859. I mention these years, familiar enough as they are, in order that more emphasis may be given to the fact that within a very few years after them the foundations of the greatest German firms were laid. Bayer and Co., Meister, Lucius and Brüning, Kalle and Co., and the Chem. Fabrik Griesheim were all founded in 1863; whilst the Badische Anilin-und Sodafabrik was started in 1865.

Nothing in their small beginnings could indicate how rapid would be their growth, and how small these beginnings were is shown by the fact that Meister, Lucius and Brüning, which, as the Farbwerke Hochst, employed, in 1914, about 8,000 workmen and over 300 chemists, found its work efficiently carried out in 1863 by the five workmen it then employed.

It is to be noted also that the men required to carry on the work of developing these concerns were already trained and at hand. The importance of the field of organic chemistry had already been estimated by such chemists as Liebig, Wöhler, Kekulé, and others, and their students were ready for the work required of them in the new factories. The advance was rapid, and the training of new men in the principles of research became an integral part of their university career. It was thought fitting for members of the best families in the country to take up the study of applied science, and honours and high positions were awarded to those who attained to eminence in it. The effect of such increased opportunities for study and the honours bestowed upon successful students inevitably created an extraordinarily large supply of trained men, with the result that salaries were always low, and firms could afford to select only the cream of the applicants that were always present in numbers whenever a vacancy in their staffs occurred.

The law of supply and demand should have operated to check this fulness in the market of trained intellects, but another and powerful stimulus began to make itself felt, a stimulus which still retained the attraction of recognised status in society, so dear to the German, and yet saved them in large measure from the necessity of undergoing the full term of three years' military training which it was necessary by

law that the whole youth of Germany should undergo. A scientific examination or a certificate of maturity or educational efficiency obtained from a recognised school or university was accepted as a reason for the reduction of this period of service to that of one year only in the class of so-called volunteers. This service could be taken in any troop, the volunteer being trained for the position of an officer in the reserve, in which class he had all the status which is accorded to a member of the officer class, with only short periods of training yearly, which reduced the hardship of military service to a minimum. Under these conditions, as well as by the national recognition of scientific attainments, the supply of highly-trained men was always in excess of the demand.

The German chemical firms were, like most of our own, begun by chemists, and it is to be noted that those that are great to-day have still prominent men in their direction whose training and habit of mind is essentially scientific, many of whom have been drawn from the class of professors and privatdocenten whose worth has already been proved by the close touch which has always been maintained between the factory and the university. I need not go into the detail of this association, as it must be familiar to all; its value as a commercial asset needs no argument.

It was in the two great branches of industrial organic chemistry, dyes and fine organic chemicals, that the effect of this application of science to manufacture was most evident, resulting ultimately in a virtual world-monopoly of these products. It is a peculiarity of such manufacture that the manufactured articles are extremely numerous and produced in comparatively small quantities, the result being that small businesses have little chance in competition with larger firms unless they be concerned in the manufacture of highly-specialized articles, in the sale of which the profits are relatively large. The prominent firms in the business became great, and their growth provided them with still more powerful weapons to withstand any attack from new commercial rivals, whether of their own or foreign nationality. As, in all industry, increased production means reduced working costs and consequently enhanced profits, the ever-growing output from these works resulted in competition of the severest kind, and internal working arrangements between firms were soon come to whereby group competed with group instead of firm with firm. The most notable of these amalgamations was the formation, in 1904, of the two great groups which included the Badische, Bayer, and Berlin firms on the one hand and the Höchst, Casella, and Kalle companies on the other.

These associations, as was inevitable, gradually came more and more together until, in 1916, the Erweiterte Interessen-Gemeinschaft was formed, which involved in its composition, besides the above groups, such firms as Griesheim Elektron and Weilerter-Meer, which had previously been in the outer circle of these associations, and many others whose businesses were more concerned with the supply of plant and materials rather than the actual manufacture of chemicals, as was the case with the members of the earlier groups. Of the methods adopted to stamp out competition I shall say nothing here. They were of the most ruthless kind, and by many asserted to be absolutely dishonest. It is, of course, arguable as to when business policy and tactics cross the line

between fair and unfair dealing, but in any case these associations left no stone unturned to eliminate all interference with their business, and no newcomer was tolerated, either in their own or other lands.

It is in no way clear when the German Government first realized how huge was the national asset that was growing up in the country, but once this realization was arrived at the industry was fostered and supported, in no half-hearted fashion, by the imposition of import tariffs and the granting of exceptional facilities for carrying on export trade, and, it is said, also by financial arrangements through the large national banks. It has been said that each of these great factories is a "potential arsenal," but how great that potentiality is was not realized, at least by other nations, until the happenings of the last five years established it in no doubtful fashion. In the face of such facts as have been established, no nation in the world, if it values its permanence, can afford to ignore the fact that the position of its chemical industry is the foundation upon which the whole fabric of its being is built up. If that foundation be ignored, the structure is unstable so long as force of arms is left as the means of settling international disputes or may be employed as a means to satisfy a nation's avarice.

It is frequently stated that the facilities offered to manufacturing concerns by the German banks are much greater than can be obtained from English banking institutions, but it is seldom that one can find a statement of the essential difference between the practice in this respect of the banks of the two countries. It may be useful, therefore, to indicate briefly what the German system is, and to show how its application has affected the growth, not only of the chemical, but of all German industries. Essentially, our banks concern themselves with investments or the financing of short-term loans on the most easily realizable security, and, though it is possible to obtain loans on collateral securities from them, these must always be of the most easily realizable character, and business over-drafts are always covered by raw or finished goods in which there is an open market. This arises essentially from the fact that the greatest proportion of the banking business is carried out on moneys deposited with the bank and not with the actual subscribed capital of the bank itself, and consequently liquidity of investments is essential to security. The position in the case of German banks is markedly different from this. It is to be noted at the outset that the cartel system is as prominent in German banking as it is in industry, even the largest of the banking concerns working in groups, to their mutual advantage.

These groups further organize themselves into sections to deal with special types of financial propositions which may be concerned with countries or industries, and large group will work in association with large group in order to handle specially large loans, their practice here being similar to that of the spread of large risks by fire insurance companies. It might be said here that such a system cannot be so safe as that of the English banks, and, for our banks, the risks would certainly be too great to carry; but the capital of the German banks is so much greater in proportion to their liabilities than is the case in England that their practice is as sound as our own. Whereas some of our largest banks show a proportion of capital to liabilities of only 5 per cent., the ratio in German banks is no less than 45 per cent., and at a

very recent date the six leading German banks controlled a capital of £137,000,000, whilst the whole English banking system, excluding the Bank of England, holds a paid-up capital and reserve of £110,500,000.

It is held as a standard of British banking, as voiced by a late president of the Bankers' Institute, that "a banker should never be a partner," but exactly the opposite is the general rule in Germany. From the underwriting necessary at the flotation of a new company, or to increase the capital of an old one, the bank is predominant and retains its interest in the new or old concerns with which it is thus associated, much to the benefit of the enterprise. Georges Lachapelle states that in 1911 the Deutsche Bank was represented on 134 different boards, the Disconto on 114, and the Dresdner on 112. A statement by W. R. Lawson is of more value in this connection than mine. He says, "German banking does not stand aloof from industry, as ours does. The men who direct the German banks are at all times in close touch with the iron and coal industries, the manufacturing and trading classes, and the ocean steam lines. With them finance, industry, and transportation go hand in hand and are regarded as integral parts of the same problem. The German banker has a finger in everything that is going on. He is represented directly or indirectly on the boards of manufacturing, trading, shipping, and mining companies. He has his eyes on all the staple markets. Underwriting is one of his recognised functions, and Germany is thereby spared many of the scandals of British company promoting. There are few commercial or industrial German ventures, be they private concerns or joint stock companies, which do not have at their disposal a fixed credit, uncovered, or covered by very unliquid securities, with one or more banks. Not only have the banks promoted most of the industrial joint stock companies and retained part of their share capital, but their managing directors remain members of the boards of these companies and draw personally large salaries for their services in this capacity."

German industrial enterprise owes a very great part of its success to this close association with the national banking interest, for the directors of these banks see to it that any appeal for public money with which they associate themselves shall be fully and satisfactorily reported upon by their large staff of industrial experts, and that their arrangements as to capital, management, and scientific assistance are approved by the highly-trained men on their boards. It leaves no question for doubt that such co-operation is a prime factor in the success of German industries in home and particularly foreign trade. An enterprise abroad, financed by a German bank, is compelled, as a part of the financial agreement, to place all orders for materials with German firms, and most generally firms in which the bank has a financial holding.

In the light of all this, the system of extended credits which have been so prominent a feature of German foreign business need only be mentioned to be understood.

So far we have discussed conditions which affect many others besides the chemical industries, and we may now consider some which are more particularly attached to this special variety of industrial enterprise. We have already said that the demand for men having exceptional training in chemical and allied sciences has always been fully met by

the German universities, and it is to be noted that the possession of a degree only is not accepted by the large firms as a warranty of fitness for a position on their staff, and in most cases a post-graduate course of two years which has been devoted almost wholly to research is insisted upon. The gateway to positions on the staff is through the research laboratory, and a further sifting out of the men takes place here before they are passed on to a post of departmental control in the works.

The remuneration of chemists in the research departments of the large works has not been on a lavish scale, for prior to the war the commencing salary was, on the average, 3,000 marks, rising to 5,000 marks at the end of four or five years. The first year of employment has always been recognised as a trial period, after which, under satisfactory conditions, a service agreement for a further four years is entered into. It has been the usual practice to reward a chemist for successful research which has been translated to the works by paying him a percentage of the profits which have accrued to the firm as a result of this work, but this form of return has for some time been looked upon as unsatisfactory, for a variety of reasons, but mainly on account of the difficulty of determining the fair proportion of the actual work done in bringing a discovery to fruition which is the result of the ability of any single individual. The tendency, therefore, has been to reduce these rewards to a very considerable extent, especially since, in some cases, the reward to the chemist has been out of all proportion to the actual work done. It has been recognised also that many brilliant pieces of work have gone without return to the chemist, merely because they have been unproductive; and in such cases a bonus has been voted to him, the amount of which is determined by the nature of the work carried out. The necessity for such a return is evident if the percentage principle is adopted, since a brilliant chemist would be penalized by having the most difficult problems set to him, whilst a man of less ability might be in the fortunate position of being set an easy task, the solution of which would bring him a high monetary reward.

The result of much inquiry concerning chemical engineers has led to the general statement that the men who can be designated by this description are the product of the works themselves. Certainly they are not accepted as such when they enter the works, although they may have taken courses at the universities specially designed to fit them for this particular branch of engineering work. The requirements as to their training are the same as those of the research chemist, but on entering the works they are attached to one of the engineers already on the staff, so that they may make a full study of the work they will be required to carry out. Usually a year or more elapses before they are given an independent piece of work to carry out for themselves, and one has only to see the results of their work to judge of the efficiency to which they attain. It is to be noted here also that it is always the chemist who holds the right of final decision as to the arrangement and construction of plant, the engineer being held responsible for the engineering work only, *i.e.*, in such matters as strength of materials, efficiency of power, application, and the like.

An outstanding fact which is constantly being forced upon one's notice in these large works is the extraordinary way in which the purely chemical industry, in its development, has carried forward with it other

industries concerned with the supply of the materials, whether for power, plant, or process, which it demands. This all-round advance of attached industries is in the greatest measure due to the utilization of applied science, and particularly chemistry, in all branches of their work.

The preparation of metals having special resisting or other properties would be impossible without the chemist, and the beautiful earthenware and enamelled apparatus which is to be seen in general use has been produced largely with his assistance.

It would appear that the standardizing of such apparatus as autoclaves, whether of plain metal or lined with enamel, of earthenware pots, tubes, and the like, greatly facilitates the work of plant erection, since it only requires a knowledge of the quantity of material to be handled in an operation to determine at once from a manufacturer's list what vessels and appliances have to be ordered, and usually they can be obtained from stock. Large stocks of such equipment as autoclaves, open and closed pans, with and without stirring gear, tiles for lining, town packings, and glass fittings are carried in the large factories, and it is an education in itself to walk through a storage yard in which such materials are contained.

There is no question that in this matter we have yet much to learn, and it may be hoped that, with the increasing demand for such materials in this country, we shall rapidly acquire the knowledge and technique which provide the German chemical manufacturer with such a wide range of excellent plant materials.

It was, of course, open to British manufacturers to obtain such supplies from Germany in pre-war times, and it cannot therefore be said that lack of them prevented the maintenance of organic chemical industry in this country, but that we were handicapped by the absence of such supplies at our own doors there can be no doubt, and we shall certainly be better able to meet competition when such a supply is forthcoming from British makers.

"My success as a man of science, whatever this may have amounted to, has been determined, as far as I can judge, by complex and diversified mental qualities and conditions. Of these, the most important have been—the love of science, unbounded patience in long reflecting over any subject, industry in observing and collecting facts, and a fair share of invention as well as of common sense. With such moderate abilities as I possess, it is truly surprising that I should have influenced to a considerable extent the belief of scientific men on some points."

—DARWIN.

Science in Agriculture.

How Denmark has Prospered.

No. II.

The Department of Repatriation, as part of its educational scheme, selected special men of the A.I.F. to study the agricultural methods of certain countries before returning to Australia. This article was written by Captain W. R. Birks, who was in charge of the party which visited Denmark, and it explains the reasons of Denmark's eminence as an agricultural country. It has been kindly made available by the Comptroller of Repatriation.

The following day at Nakskov Mr. Possmussen took charge, assisted by several of his neighbours, who turned up with motors and carriages enough for all. The day was spent in driving through the district and in inspecting particularly Mr. Possmussen's farm "Fredsholme." This is a 1,300-acre property all farmed on a normal eight-year system, and a good proportion of the crops is allowed to go for seed. The thrasher was seen at work in a field of seed turnips of about 50 acres. The haulms from these were stacked in the field for burning. There were other similar blocks of cocksfoot, carrots, and mangels either waiting for the thrasher or ripening. Mr. Possmussen is considered one of the most successful farmers in the country, having started himself "from scratch." His system of bookkeeping is exceptionally good even in this business-like community. A separate account is kept for each cow, showing thus not only her individual yield, but the total food she consumes. The same can be said of each family of pigs, and each field is also separately "costed."

What is perhaps the nearest approach to a "stump-jump" arrangement to be found on this side of the world was seen on a tractor plough on this farm. The furrow is held in position by a wooden peg which breaks, letting the furrow up, on contact with a rock, and has to be replaced.

Two days in Langeland were spent in visiting two pairs of contrasted farming propositions. The so-called "peasant" farms of Mr. C. Pedersen and Mr. Fogelgaard on the one hand (though these are much more comfortable properties than the name implies, being of about 100 acres each) and the estates of Count Hans Ahlefeldt-Laurvigen and Foedal Count Ahlefeldt-Laurvigen.

On the former two the most striking feature was the improved quality of the dairy stock as compared with the average of the large herds already seen. Each of these gentlemen runs about twenty cows besides young stock, and the majority of these were of a good dairy

type. It must be confessed that up to this time the Red Dane had on appearances been rather disappointing, though even in the largest herds the records showed very creditable and profitable returns.

Mr. Pedersen's farm was thoroughly inspected. His 80 odd acres of cultivated land carry thirty-seven head of large stock (including four working horses) and ten pigs, though the normal number of the latter is forty. He employs an overseer and three permanent hands and an equal number of Polish girls during the busier season. One field is devoted to experimental work, and a great deal of the cropping is for seed production. Mr. Pedersen showed with justifiable pride a small area of mangels estimated to yield about a ton of seed per acre and carrots promising half that return. And the war prices for carrot seed in particular have been fabulous. It is probably correct to say that the increase was one-hundred fold. Much the same applies in the case of home-grown tobacco. These abnormal prices have rather disturbed the ordinary course of Danish farming, and it is still apparently a little doubtful as to how things are going to settle down again.

For the rest Mr. Pedersen follows the ordinary eight-course rotation, though in place of the grass mixture lucerne is substituted. This is general in Langeland, and at the Foedel Count's farm in particular some fine paddocks of lucerne were seen. Here it is left for three years, being sown with oats or barley and ploughed up after three years to go back into wheat. Hungarian seed is preferred, but Italian, which must now be employed, is fairly satisfactory for a three years' stand. A great deal of hay is made, but the lucerne also provides the major part of whatever summer grazing the stock get. The effect of this was the subject of special inquiry, and Mr. Koch (the Foedal Count's inspector or farm manager) was emphatic. In spite of the quick and uniform feeding off insured by the tethering system, still, cutting does give better returns, and is better for the "stand."

To describe even the part of the Foedal Count's estate seen would be a work in itself. In the village under the shadow of the castle is a small private agricultural school, the students working on the main farm for the most of their time. There is an officer of the State Department of Agriculture residing on the estate. This gentleman seemed to be there to watch and study on behalf of the Government the experimental work being carried out by the estate. As far as the latter was concerned he did not seem to function even in an advisory capacity.

Among other work in progress there were shown three herds of dairy stock undergoing a comprehensive test. There were a pure Jersey herd (the first examples of any foreign breed met with), a pure Red Danish, and a first cross herd. The general impression gained of the results to date was that the Jerseys were giving inferior returns to the Red Danes, while the cross came third. Possibly there was some misunderstanding here. In any case some very interesting information and opinions were heard on this point later.

The dairy, situated some miles from the castle, is run on strictly commercial lines, but with its tiled interior, and the scrupulous cleanliness which its rules enforce, can be likened almost to an operating

theatre. The buildings too have quite a nice appearance exteriorly, and are set off by a broad belt of well-kept lawn and flower garden, and the senior officers connected with this establishment bore quite a professional air.

An interesting side line at Tranekar and one frequently combined with farming throughout Denmark is the production of peat. It is sometimes simply cut out in blocks and stacked to dry. Here an outfit was seen for digging, grinding, and puddling the material. It is then poured out on green turf in a 4-inch layer and stamped, so that it dries into brickettes. The percentage of combustible material varies from 50 to 70 per cent. or even higher, and the stuff is worth just now up to 30s. a ton. In some places boiler plants were seen burning nothing else but high-grade peat. It is, however, generally used to eke out the meagre and very expensive coal supply.

On Fyen, a larger island, a couple of days full of interest were spent in visiting several farms and institutions in the neighbourhood of Odense—the third city of Denmark. Odense, by the way, might well serve as a model for the municipal authorities of our growing country towns at home. It is, almost, the city of the idealist in being. The municipal band performs daily in one or other of the city parks or gardens, and if there is poverty there are at least to be seen no outward signs of anything but contentment and comfort.

Another prosperous and go-ahead firm of seedsmen, L. Daehnfeldt Limited, provided a fleet of cars, and sent things along with a swing for the best part of a day. First we inspected the company's show-rooms and flower seed store, then another huge establishment for handling farm seeds. This included one new building in reinforced concrete throughout in which the machinery is not yet completely installed. This place the firm claims will be the most modern and efficient of its kind in the world. The amount of building which is going on, by the way, all over Denmark, in spite of high prices, is remarkable.

There was a drive of several miles through farming country, and the crops seen were almost all for seed purposes. These were on the firm's own as well as contract farmers' land. In the testing and breeding fields a party of 100 Danes, both men and women, were met. These were members of an agricultural association, and probably contract growers come from an outlying district to study latest developments. They too were travelling in the firm's motor lorries, a fleet of which is kept for this purpose almost entirely. Besides pedigree strains of all sorts of farm crops there were seen growing a patch of pansies which a sheet might cover, but worth some thousands; and hot-houses of cucumbers and tomatoes, the seed of which is sold individually at 3d. or 4d. each.

The Dalum Agricultural School is situated in this neighbourhood. A still more elaborately equipped example of this type of institution was seen later at Ladelund College on the Jutland mainland, but a general rough outline may here be given of the purposes these schools serve and the lines on which they are run. As was previously mentioned they number about seventeen in all Denmark. They seem to have been founded like many other types of schools, as private ventures, and later on enlarged by the aid of capital subscribed by appre-

ciative ex-students (who do not draw the interest on their investment), and by loans from credit societies. In the case of Ladelund, for instance, it was gathered that the subscribed capital was about £3,000, and loans raised total about £12,000, while the total value of the property was estimated at £25,000. The farm, which is generally from 100 to 200 acres in extent, is the financial mainstay, and is therefore always thoroughly and very efficiently worked. The only State assistance received is a small subsidy, which varies from about £150 to £300 per annum, according to the size of the school. The State also pays 50 per cent. of students fees in cases of special necessity. These fees on the average work out at about £1 a week, including board, accommodation, and instruction. The school is governed by a small committee consisting of the director and senior instructors, residents, generally, of the surrounding districts. The governing idea of the teaching is that students must learn practical work on practical farms, and come to the college therefore only to get theoretical instruction. The agricultural and dairy courses therefore cover a single winter term generally of six months, in some cases nine.

In the early summer domestic economy courses for young ladies are generally put on, and during the three harvest months (July-September) the school is closed. At Dalum the teaching staff number ten. Besides lecture rooms and library there is a laboratory used chiefly for dairy and bacteriological work, and an excellent museum of agricultural and dairy machinery, implements, and utensils. This museum is a feature of Danish farm schools, and generally occupies a large shed or hall with an upper gallery running right round the interior. The students come chiefly from the farming districts, and number in summer about forty to sixty for domestic economy, and up to 250 for the main winter term. They are all resident, and live one, two, or three in a room. The living is by no means luxurious, but the general environment of these schools seems very fine indeed, and a very good *esprit de corps* is evidently developed. There is a dairy of course run in connexion with the farm, and supplied also by neighbouring farmers. At Dalum the dairy has a capacity for handling 1,200 gallons a day, and supplies pure milk to hospitals in Odense. The dairy herd too, of pure Reds, is specially good. Here at last was found a byreful of stock to please the critical dairyman. There were thirty-four milkers, all of a good dairy type. The average yield was given as about 1,000 gallons, and the average test 3.65 per cent. This it must be said stood out as far and away the best herd seen during the tour. On several other farms, however, individual cows showed the quality one would expect. On the other hand, of course, the stock were seen at a disadvantage. The last few years, and especially last winter, have been particularly hard on the cows, owing to the shortage of imported foodstuffs; American maize seems to be the great stand-by normally.

From the Dalum herd bull calves have been sold up to £400. Cows of the type seen here are apparently not to be bought just now, but the price of a good average milker was given as about £40.

One of the farms visited in the Odense district was of special interest. This was Mr. A. Andersen's property at Langeskor, where is situated a pig-breeding centre. The function of this institution is to test pigs, both boars and sows (by the fattening propensities of their progeny)

for admission to the herd book. The breeds dealt with are Danish White and Large York White, practically the only pigs seen in the country. On application from a farmer a local committee visits his farm and inspects the animals proposed for the herd book, to judge as to type and general appearance. If these are found satisfactory four of the progeny of the animal in question are sent up to Mr. Andersen's piggery after weaning. Here they are fed in one sty until ready for the butcher as baconers, *i.e.*, about 200 lbs. live weight. This takes from four to six months. All food given them is weighed, and all pigs under observation are of course treated similarly. Every fortnight each "family" is weighed, and an exact record of the use they make of their food is thus obtained. What the exact standard of rate of fattening is could not be ascertained, but Mr. Andersen was understood to say that a good youngster should grow to 200 lbs. live weight in from six to seven months after consuming from 700 to 800 "units" of food. For this purpose 1 lb. of grain is reckoned a "unit," and as equivalent to 6 lbs. skim milk, and 10 lbs. mangels or other green stuff.

If a family pan out satisfactorily at the bacon factory, *i.e.*, after slaughtering, a second—confirmatory—test is ordered from another litter by the same parents, and after passing the double test the aspiring parent or parents are eligible for entry in the herd books.

By way of recompense for the work and trouble involved Mr. Andersen gets the weaners at half the market value, and he takes the full proceeds from the bacon factory. This 50 per cent. of the value of the young pigs is paid by the State, and amounts to about 25s. per pig on the average. The Government thus secures a highly technical service efficiently rendered at what seems a very low cost, a feature very typical of Danish agricultural administration.

The piggery in which the "control" litters are fattened seemed a well adapted affair. There were fifty sties, each about 8 feet by 8 feet, completely closed in under one roof. A gangway running lengthwise between the sties and a crossway in the centre leading to the food rooms on one side and weighbridge on the other. The walls of the sties stood about 2 ft. 9 in., and consisted of reinforced concrete 2 inches thick and strengthened at the corners. At the back of each sty a space for dropping is partly partitioned off, and about half the floor of the main apartment is raised about 6 inches and covered with straw bedding.

All the larger piggeries seen were something after the same style of construction. War conditions of course have reduced stock tremendously; the larger estates visited had accommodation for from 300 to 700 head, but at present nobody is carrying more than 20 or 30 per cent. of normal stocking in pigs.

On the outskirts of Odense there is a unique institution called the "Small Holders' School," governed by a Mr. Jacob Lange. Mr. Lange, besides being a horticulturist of some note, is also an ardent educationalist and social reformer. In a short but very interesting address he explained that the school is organized and conducted almost similarly to the ordinary agricultural schools, except that it is owned by the Small Holders' Association of the whole country, and draws its students principally from this class of people.

A "smallholder" is a settler owning something less than 10 acres of ground, whose steading consists of a single gable building including residence, barn, and byre.

Besides the ordinary subjects connected with agricultural, dairying, gardening, and domestic economy, a wider field of study is covered. Students generally elect to take some extra subject such as general or Danish history, literature, social economics, &c.

In addition to the ordinary three or six months' courses provision is made for very short terms, as short as eleven days in some cases, for adults. These courses must resemble the summer schools of our own Workers' Education Association; people come to them from the remotest "back-blocks" and islands, in order to get in touch with modern thought and general progress, in order, as Mr. Lange puts it, "to move forward together."

Mr. Lange explained that the lead in enlightenment and reform had always come in Denmark from the agricultural community, and not from the cities as in our own country. This no doubt accounts for many things in this country which seem remarkable to outsiders. On the question of land settlement Mr. Lange said he could not conscientiously advise young people to acquire land at present, even with the very liberal assistance of the Danish Closer Settlement Act. Incidentally he referred with evident admiration to the rational system of land valuation and taxation in Australia.

It is unfortunate that time did not permit of more than a hurried look over the establishment. There were seen a 10-acre experimental orchard, a few fields of the farm of some 80 acres, the extensive gardens in which are grown small fruits, vegetables, and flowers on a commercial scale, a cookery class at work under the supervision of Mrs. Lange, who is as keen an enthusiast as her husband. The visit by the way was responsible for a series of disasters to various dishes which happened to be at their critical stages. Before leaving the Small Holder School it is to be remarked that this was the most pleasantly situated of all the very cleverly laid out farm schools which had been or were later visited.

The first day on the mainland was spent in driving about the district of Fredericia, near the present Jutland-Schleswig border. Short halts were made at several farms and dairies. Among the former Dougaards Brothers' 150-acre property seemed particularly well worked, and carried fine crops of wheat, oats, rye, barley, mangels, and peas, all promising exceptionally heavy yields. A mixed horticultural and dairy farm belonging to a Mr. Kromann was cited as an approximation to the ideal in the way of smaller holdings; though with 10 acres of faultlessly worked orchard and garden and 15 acres under general crops, and supporting eight head of dairy stock and as many pigs, Mr. Kromann seems to be making very handsome money. Here every product of Danish soil seemed to be raised, including hazel nuts, honey, flower seeds, all manner of small and large fruits, besides those of the ordinary farm and dairy. The land moreover was a poor, whitish sand hill twenty years ago. Good cows and pigs were seen on all these smaller places; in the case of the former odd ones had reached the 1,000 gallon mark.

Near the Pjedsted dairy there is a place called a "farmers' seed factory," really a corn and seed drying and pickling establishment, another and quite a recent co-operative enterprise.

All seed which is to be kept for sowing, and much of that for milling, must be artificially dried in this country. The method adopted here is that used by all the up-to-date seedsmen. The bags are not emptied; they are laid over holes in the floor which they just cover. Hot air (130 deg. F.) is then forced through them for from six to eight hours. As much as 10 per cent. to 15 per cent. of moisture is thus removed. Last year, to quote the information as it was received, 19,000 tons of grain were treated. This was members' grain which had been sold to the Government, and the latter paid 25s. a ton for the drying.

Pickling is done by the hot water process, and oats and barley only are treated. For wheat and rye bluestoning is reckoned quite satisfactory, and this is done on the farm. The hot water plant was put in by a Copenhagen firm, and the process is roughly this: Hot water is kept circulating from the main tank by a pump which feeds it through a system of valves back to the tank again. The temperature of the water as it passes through these valves is kept constant at 130 deg. F. by the automatic admission of steam. This is governed by a thermostat. The seed in bags is first soaked in cold water for six hours, then hoisted into the hot tank and left there for five minutes, from there it passes under a cold shower. After draining it contains 30 per cent. added moisture; this is dried out in the manner explained previously, and the seed is returned to the farm at 90 per cent. of its original weight. The cost to members for this treatment was given as a rate which works out to a rather high figure, 2s. 6d. per 3-bushel bag.

Apart from the properties visited this day, very interesting characters were met in the gentlemen who acted as guides. These were Mr. T. J. Brash, Dairy Commissioner for Jutland and Fyen, Mr. M. Olsen, Agricultural Counsellor for the Fredericia District, and Mr. M. H. Lund, who had one time farmed in New Zealand, and did yeoman service as interpreter.

The two former were very willing to discuss their status and duties, and as these resemble somewhat those of the inspectors of the Department of Agriculture in New South Wales the opportunity was fully availed of. Mr. Brash is employed solely by the State. He has a large area of country as his field of operations, but is not burdened with any routine administration or even experimental work. His services are available to any society or individual within his district for advice on special matters, and he is free to move about to investigate and report on any new developments affecting the dairy industry. Of this class of officer it was gathered there are three for all Denmark.

Mr. Olsen on the other hand has a strictly limited district to supervise. He is one of about thirty men so employed in Jutland alone, to advise and assist farmers in their general agricultural affairs. It was gathered that there is a still greater number of dairy counsellors working in the same area. Mr. Olsen is employed and paid by the local Fredericia Agricultural Association, and in part by the Jutland Society to which the local bodies are affiliated.

Both the local associations and the superior organizations are subsidized to a small extent by the Government, but Mr. Olsen is responsible only to his own local body, that is his neighbours whom he serves. There are within his district about 2,000 settlers with holdings greater than 10 acres, and the majority of these are members. The farthest is within cycling distance (about 15 miles), and they are all either on the telephone or within easy reach of a neighbour's instrument. Mr. Olsen could therefore scarcely be in better touch with his district. Some of his various duties may be listed thus: The purchase of stud stock and high class seed for members, the keeping of records for various classes of herd-book stock, and forwarding consolidated returns to the society's head-quarters; conduct of demonstration and experiment plots on his own and about twenty other farms; acting as managing director of the seed drying and pickling establishment; the delivery of about a dozen lectures a year to meetings of the association; writing on agricultural subjects for the local press; and, lastly, by far the greater part of his time is occupied in replying to members' inquiries chiefly by 'phone, and in visiting their farms to investigate special difficulties, and give personal advice on the spot. With all this Mr. Olsen still finds time to supervise the farming of his own land. He was inclined to apologize for his own husbandry owing to pressure of his public duties, but what was lacking in the thorough working of his farm was not at all apparent. It was gathered that Mr. Olsen was elected to the post of counsellor by the members of the association, and the considerations which doubtless weighed in his selection were, besides his profound knowledge of the principles and practice of agriculture, the fact that he is possessed of tact and other strong personal qualities, and, above all, that he had made a thorough success of farming in the district, whose prosperity as a whole it was his duty to advance.

"That man, I think, has had a liberal education, who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine with all its parts of equal strength and in smooth working order; ready, like a steam-engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of Nature and of the laws of her operations; and who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of Nature or of art, to hate all vileness, and to respect others as himself."

—HUXLEY.

Personal.

Mr. A. E. V. RICHARDSON, M.A., B.Sc.

Mr. A. E. V. Richardson, whose portrait appears in this issue, occupies a foremost place in the ranks of agricultural scientists in Australia. Since his association with the Victorian Department of Agriculture as Agricultural Superintendent, which dates back to 1911, he has initiated and controlled the experimental work on the State experimental farms, and has been largely responsible for the impetus given to the technical development of agriculture during the past decade.

Mr. Richardson came to Victoria from South Australia, where he occupied the position of Assistant Director of Agriculture. Success, therefore, came to him early in life, for he is now only 36 years of age. Rapid promotion, however, was but the fulfilment of the promise of youth. His collegiate and university record was a brilliant one. He was dux of the Adelaide Agricultural School in 1898, and in 1901 won a first class diploma of the Roseworthy Agricultural College. In 1907 he graduated Bachelor of Arts, and in 1908 Bachelor of Science. Two years later he obtained the degree of Master of Arts. First class honours were won in chemistry, agricultural chemistry, botany, biology, and geology, and he was highly commended by the Sydney University for his thesis for the science degree in Agriculture.

Wheat-breeding, and the advancement of the wheat-growing industry by improved cultural methods was one of the first subjects to which Mr. Richardson directed his attention. For two years he was superintendent of the Parafield Wheat-breeding Station in South Australia, and the work which he accomplished there soon brought him under the notice of wheat-growers, and he was successful in securing their co-operation for the carrying out of field experiments, and the testing of new varieties. It is interesting to note that Gallipoli, a new variety, which during the last season gave specially good results in the Mallee and the drier wheat-growing areas of Victoria, was crossed by Mr. Richardson while at Parafield, and it was later fixed by him at the Werribee Research Farm.

The establishment of the Research farm at Werribee in 1913 inaugurated a scheme of experimental and investigational work of great magnitude, and of far-reaching importance. There always has been, and probably there always will be in some quarters, opposition to the expenditure of money for agricultural research. The history of the agricultural progress of the United States of America, of Denmark, and of Germany during the last thirty years shows the benefit conferred upon those countries by sustained scientific investigation, and as time goes on the value to Victoria of the Werribee institution will become more and more apparent. Notwithstanding that much of the experimental work had to be abandoned during the war period, the results so far gained must tend to improve general farm practice, and so increase production; but

even greater benefits may be expected in the course of years from an exhaustive inquiry into physical and biological problems affecting cultural operations. Mr. Richardson has included in his scheme the improvement by selection, stud breeding, and hybridization of wheat, barley, oats, and other economic plants; investigation into soil renovation, fertilizing, and tillage methods; rotation of crops and improved cropping practices; irrigation investigations; improvement of natural pastures, and trials of artificial grassing with exotic and native grasses, and many other lines of inquiry.

The substantial advance made in the average yields per acre of wheat in Victoria during the past ten years is one of the results of active educational and propaganda work by the Department of Agriculture, and has returned an infinitely larger sum to the State than the State has spent upon agricultural science. About ten years ago the quantity of chemical fertilizers applied per acre was about one-half of the present day application, and this increase has been brought about largely by demonstration on Government farm plots, and on private farms whose owners were induced to assist in an educational movement for the immediate benefit of the surrounding districts. Not only has the grain yield been largely increased by this more generous treatment, but an additional advantage has come to the farmer by the subsequent improvement of his pastures, and an increased stock-carrying capacity.

In 1918 Mr. Richardson visited the United States of America on behalf of the Victorian Government, and his report upon his inquiries has done much to stimulate interest in Australia in the subject of agricultural education and development. Acting upon his recommendation, the Government last session gave statutory authority for the appropriation of £10,000 per annum for the next ten years to be spent upon agricultural education and research. "The future of Australia as an agricultural country depends upon the extent to which she can use trained specialists to increase crop production" is the doctrine which he preaches. Mr. Richardson, who is a member of the Executive Committee of the Institute of Science and Industry, has always taken the keenest interest in its work. "The Commonwealth Government," he states, "can largely assist the agricultural development of the States by the systematic investigation and introduction of plants, and testing them over a wide range of soil and climate, and by the establishment of bureaux for animal diseases and plant pathology."

Tropical Agriculture: Cotton, Jute, Flax, Linseed, Castor.

By DANIEL JONES.

I would like to draw the attention of the Institute of Science and Industry to industries which I think might be carried on by utilizing certain raw materials which could profitably be raised in this country.

With respect to cotton-growing in Queensland, a considerable amount of misconception has gained ground as to the amount of assistance this industry has obtained by bonus from the Public Treasury. It is frequently asserted that as soon as the bonus provisions lapsed the industry collapsed. Nothing of the kind occurred, for the very sound reason that the bonus provision of £5 per bale exported had ceased to operate long before cotton-growing was discontinued. We found that when the value of cotton was equal to what it has been during the past fifteen years, the profits accruing were satisfactory, but a drop to a penny per lb. for raw cotton in seed was largely a non-paying proposition; hence farmers speedily left off growing the crop. However, the bonus paid, being in the form of a land order to the producer of the cotton, had, indirectly, a beneficial effect on the close settlement of what are now the most prosperous farming districts of Southern Queensland.

Evidence of this may be seen by any traveller through the Logan, Fassifern, and Rosewood farming centres. Here one realizes the value of diversified farming, and small holdings furnishing a large population with a profitable means of livelihood.

Most of these areas were selected by farmers who, for their sons, utilized the bonus land order to take up homesteads of from 40 to 80 acres, and those districts are studded to-day with comfortable homes and farm plots, due largely to the impetus given to this—the best form of home-making—by the utility of the cotton plant as the factor in closer settlement.

Hundreds of farmers grew cotton in that period after the lapse of the bonus, hence, much of what is surmised as to the effect of the bonus lapse is entirely mythical.

When a revival of the industry occurred about the year 1890, due to the unselfish efforts of the farmers and mercantile community in Ipswich, whose ambition was to revive the industry, not only on growers' account, but as relating to textile manufactures, a further bonus was sought for, and after much delay and opposition, a proviso was made by the Legislature that on the manufacture of £5,000 worth of calico or other cotton fabrics, the money would be paid. This regulation prompted those who were interested in the industry to establish the Queensland Cotton Manufacturing Company, which, after much effort, was capitalized to a very insufficient amount, and started operations at East Ipswich.

After a struggle for about five years, the company ceased operations, owing to insufficient capital, but primarily to the apathy displayed by the Government then in power in not safeguarding the interests of the company by carrying out Tariff regulations provided by the Customs Act. This can be best explained by a brief discursive statement of fact. The directors, after some inquiry and tests, discovered that a line of manufacture best and most profitable for the company's activities related to the making of Turkish and honeycomb towels. The necessary machines were imported expressly from England to perform this work, the incentive being a duty of 15 per cent. on this class of goods, as against a free Tariff, or at most 5 per cent., on the other articles made in the factory, which, for the most part, comprised narrow calicoes, broad sheeting, twills, cellular cloth, butter and cheese cloths, all of superior excellence, which speedily caught the attention of the local trading houses.

Our enterprise in making these towels was, for a period, eminently successful, until importers of cotton textile goods in the State found that, by importing towels in bolts, the selvedge being uncut, they were classed as piece goods, and admitted duty free. This proved the Waterloo of our textile manufacturing at Ipswich, and from that time the plant has been largely scrap iron.

I have emphasized this feature of our manufacturing enterprise in order to correct a false impression that the cotton-growing and manufacturing industry failed by inherent economic conditions adverse to the enterprise rather than those which could, by a little business acumen and sympathetic treatment, have been

entirely avoided, and a useful industry be continued, particularly as economic conditions have improved in relation to this pursuit.

Cotton Yarns were made by the Ipswich Cotton Company from local fibre in 1890. Customs imports of this material for 1916-17 amounted to £70,422 with a Tariff of 15, 10, and 5 per cent., and £61,181 from United Kingdom for use of manufacturers.

Candle Wicks were manufactured by me as a separate industry from the factory operations. Customs imports for 1916-17 show £8,600 for candle and lamp wick.

The manufacture of *quilts* from cotton wadding is an industry now carried on in Brisbane to some considerable extent. Messrs. McDonnell and East, having taken the industry in hand, are selling large quantities of the article manufactured.

Wadding, such as is manufactured for medical purposes, can be made in Brisbane. I have forwarded samples for your inspection. A local business firm would engage in this industry if the Tariff would promise a successful home market. I trust that this aspect will be given full consideration by the Institute, and that they will see the importance of making the cotton industry a national question. It is practically certain that other States, as well as Queensland, are able to grow cotton successfully. Customs imports of waddings and cotton wool for 1916-17 show £10,274, and 15 and 20 per cent. duty.

I may say that, although experience of the 1918 drought has been very serious to farmers in general, the cotton crops have withstood the drought, and, generally speaking, given satisfactory results. This is one particular fact in the cotton cultivation. The hardihood of the shrub in this respect has been tested in past seasons, and has given every indication of its value as a reliable crop during unseasonable conditions.

The Jute Plant has been growing in the neighbourhood of Brisbane very successfully, and there appears no reason, if Tariff assistance was given in the manufacture of jute goods, why all the necessary material should not be grown in Queensland.

The manufacture of *woolpacks*, and the production of the raw material, together with the manufacture into articles required, would solve the problem of the unemployed, and also provide profitable activities for as many new settlers as we are likely to have for some years. Customs imports for 1916-17 show £268,995 -all Indian woolpacks.

Reaper and binder twine might, perhaps, be made from the various plants of the Aloe or Agave and Banana family. There are many of these which grow in Queensland so profusely as to indicate success in the manufacture of binder twine if tested. This, I think, would be useful work for the Institute to engage in. Customs imports for 1916 17 were £43,720 for this material.

Flax has been grown on the Queensland coast and downs both for straw and seed purposes in an experimental manner. Excellent linseed flax has been raised at the Acclimatization Society's ground, near Brisbane, from pedigree seed brought from England.

Linseed is a crop which has been grown experimentally, and some very fine examples of flax and linseed from the Darling Downs and inland districts have been exhibited in Brisbane. I would suggest that the Institute might give publicity to these articles. The importation of linseed for 1916-17 amounted to £165,000—India, £162,000.

With regard to *castor oil*, some apprehension exists in the minds of Brisbane growers that the price offered for castor beans is not so high as it should be at present. If the Institute could guarantee a price for a number of years, the industry would be to more advantage, the farmers having more confidence in the crop.

Castor bean proves itself to be a drought-defying crop, just as cotton is, hence in these two industries we have ability to rapidly add to our agricultural exports, and thus promote close settlement. Customs imports show castor oil in bulk for 1916-17 value £27,894, and 6d. and 8d. duty per gallon; and cotton-seed oil, £26,913, and 2s. and 2s. 6d. duty—if denatured, 6d. and 8d. per gallon.

These matters have been brought under the notice of the Institute in view of the probability of starting them as secondary industries assisting those primarily related, as most of these industries would be suitable for unemployed returned soldiers. I think that the whole of these questions might be gone into from an economic or commercial stand-point.

REVIEWS.

Botany for Agricultural Students, by John N. Martin, pp. x + 585, John Wiley & Sons, New York, 1919. Although the author has written this book primarily for agricultural students during their elementary college or university course, he has accomplished probably much more than he set out to do. His work will interest a wider circle of readers than students learning the rudiments of botany. Naturally it treats the subject from the economic rather than the systematic aspect, and it links up in a clear and helpful manner a knowledge of botany with the wider science of agriculture. Few authors have managed to invest the study of botany with a sufficiently practical interest, and the average student, instead of being attracted to an understanding of the fundamental principles of the functions of plants, and all that relates thereto, has given only scant perfunctory attention to his text books. Professor Martin's book, however, is more than an elementary guide. It provides a valuable introduction to the principal features of the science, and surveys broadly the whole range of plant life. The chapters on the algæ, for instance, and on fungi and fern plants, are dealt with much more fully than in most text books of a similar character, and the pages lack nothing of scientific value by being handled in an agreeable manner. One object aimed at is to give a general knowledge of cultivated plants, of plants not cultivated, but like the rusts and smuts, related to agriculture, and of those plants which one must know in order to understand the evolution of plants. Another purpose is to give such a general knowledge of plant anatomy and the function of plant structures, that one will have the necessary knowledge for the study of such agricultural subjects as horticulture, forestry, and farm crops, and also a basis for the study of the special botanical subjects. The book is divided into two parts. Part I. studies the different phases of the plant as they occur in relation to each other, while Part II. is devoted chiefly to a study of plants as to kinds, relationships, evolution, and heredity. The footnotes given will enable a student who wishes to prosecute his studies in one particular branch, such as morphology, plant pathology, taxonomy, &c., to do so. An admirable feature of the book are the photographs. The reproductions are excellent, and help to a quicker realization of the subjects they depict, an object not always attained by the employment of illustrations.

The Right Use of Lime in Soil Improvement, Alva Agee, pp. iii + 89 (1919), Orange Judd Company. This book should prove of considerable value to all cultivators of the soil, as it adds materially to the knowledge gained upon this important subject. Apparently farm practice in the United States of America has progressed far beyond the general level of Australian methods—if a mean can be struck between the best and the worst of our ways of doing things—for the author states (Chapter IX.) that "a bulletin of the New York Agricultural Experiment Station, published early in 1917 calls attention to the rapid increase in demand for ground limestone in New York. Within the last five years the number of grinding plants within the State had increased from 1 to 56, and more than a dozen outside plants are shipping extensively into the State." Too often too much is expected from lime. Although it can neutralize arid soils, it cannot take the place of drains in water-logged soil, nor does it altogether obviate the use of cultural implements or fertilizers, as is frequently imagined. Intelligent men who like to reason things out for themselves will receive plenty of assistance from this new text book.

[Photo. by Harold Cazneaux.

Mr. F. LEVERRIER, K.C., Chairman of the New South Wales Committee of the Institute of Science and Industry.

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

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Liquid Fuel.

THE British Anti profiteering Sub-committee on the Price of Motor Fuel has reported that the situation as regards supplies of petrol is alarming, and has strongly expressed the opinion that the ultimate solution of the liquid fuel problem is the production of alcohol for power purposes. Discussing this report in a recent speech at Sydney, the Prime Minister pointed out that the question of liquid fuel supplies is of vital importance to Australia from the stand point both of national defence and industrial development. The Commonwealth depends almost solely for her supplies of liquid fuel upon the outside world, and imports about 20,000,000 gallons of petrol, and a larger quantity of kerosene, per annum. These supplies are drawn not even from other parts of the Empire, but from foreign countries. Any circumstances which deprived the Commonwealth of its requirements would seriously embarrass the industrial life of the community, and would practically paralyze all efforts at defence from outside aggression. From the industrial point of view alone, Australia has everything to gain from a thorough exploration of all possible sources of liquid fuel unless she is content to continue to pay more than her competitors for a commodity which is now the basis of modern industry.

The assurance of the Prime Minister that the Government would do anything in its power to encourage the manufacture of power-alcohol for fuel purposes, and that, for that purpose, the services of

the Institute of Science and Industry would be called in, will therefore be welcomed by those who have given any thought to the question. Experts are agreed that the supply of petrol must in the not-distant future inevitably fail.

Every year the world's demand is increasing prodigiously, and the price is rising. In the United States of America alone, notwithstanding civilian economies to make provision for war requirements, the consumption increased from 1,200,000,000 gallons in 1914 to 2,680,000,000 gallons in 1918—an increased annual consumption in five years of 1,480,000,000 gallons. To the enormous growth of road motoring during recent years there will now be added the requirements of high-grade petrol for aeroplanes and airships. Commenting upon this point, His Majesty's Petroleum Executive, in a report of the Inter-departmental Committee on various matters concerning the production and utilization of alcohol for power and traction purposes, asserts that "no limits can be assigned" to the development that may be anticipated in those directions alone. "Whilst it is impossible for us," states the report, "to forecast the development of total petrol consumption of all countries, and for all purposes, facts are not wanting to indicate the likelihood in the not-distant future of so great a pressure of demand as to cause, at any rate, a very high level of prices, and we are satisfied that close investigation should now proceed with the object of providing alternative supplies of motor fuels derived from new or supplementary raw materials."

The main question affecting the use of power-alcohol is one of price. Investigation of the problem was delayed in Great Britain in 1905 until such time as there might be an approximation between the prices of petrol and spirit sufficient to create a practical alternative of choice between the two. The Expert Committee in Great Britain has now reported that "we are satisfied that the time has come for Government action, which should pay due heed to both current and prospective prices for petrol, or other petroleum products, benzol, and alcohol motor fuel or its admixtures." Under the pressure of war stimulus the production of industrial alcohol in the United States of America increased from 14,000,000 gallons in 1915 to 50,000,000 gallons in each of the years 1916, 1917, and 1918.

Comparing economic conditions as they exist in Great Britain and in Australia to-day, and having regard to the possibilities for enormous agricultural expansion in this country, Australia is in a better position, perhaps, to encourage the production of power-alcohol than is the Mother Country. The Institute of Science and Industry has already issued a report upon the yield of alcohol obtainable locally from various substances, and it has investigated the most likely of our raw materials. From the technological stand-point, the ideal raw material is sugar molasses, of which Queensland produces annually 10,000,000 gallons. The possible sources of the supply of power-alcohol are inexhaustible,

for it can be distilled from any material containing sugar or starch. Alcohol can, therefore, always be made in the locality of the demand if crops are grown for the purpose, and consequently farmers could co-operate in the distillation of the raw material, and produce a cheap liquid fuel having many distinct advantages over petrol. While the price of petrol, in view of the ravenous demand for it, is almost certain to continue to increase, the cost of production of power-alcohol will show no such tendency. The principal objection to the use of the latter—the difficulty that may be experienced in starting the engine from cold—has already been removed, as the result of experiments carried out by the Institute.

Another source of liquid fuel is coal. Great Britain, the United States of America, and Canada are now spending large sums of money upon the chemical investigation of their coal resources with a view to the more economic treatment of their rapidly diminishing supplies. It has been stated that Great Britain alone loses by-products from her coal to the value of £200,000,000 per annum, and that if the existing indiscriminate and wasteful methods were replaced by the most economic means of consumption, not only would she be able to manufacture sufficient benzol for her own use, but would also obtain large quantities of sulphate of ammonia and other chemicals, which form the basis of explosives, dyes, &c. This estimate is probably a scientific more than a practical one, but it indicates the tremendous waste that takes place owing to a complete disregard of economic principles. A great deal of successful experimentation has been done recently in Great Britain and the United States of America upon the recovery of the volatile by-products and the utilization of the carbonized products, which as fuel is, in many respects, far superior to coal. Some time ago the Institute of Science and Industry appointed a strong and influential committee to inquire into Australian conditions, but unfortunately little has been done, as no funds were available for the committee to carry on its work.

If practically the whole of the New South Wales output of coal were carbonized in by-product coke ovens or retorts and the benzol were saved, we would expect to get at least 17,000,000 gallons of benzol from the 8,500,000 tons of coal. In addition, other valuable by-products in the form of sulphate of ammonia and tar would be recovered. The value of the by-products now wasted per ton of coal is estimated at 17s. 4d., which is considerably more than the value of the coal itself at the pit's mouth. Sir Ross Smith has recently directed attention to the importance of Australia making herself independent of outside sources of supply of liquid fuel. From the defence point of view in connexion with aviation and motor transport, as well as from the stand-point of general industrial development, the importance of the matter can scarcely be over-estimated.

E. N. R.

EDITORIAL

POWER-ALCOHOL.

In view of the shortage of petrol, it is not surprising to find that the question of utilizing alcohol as a liquid fuel is being taken up in many countries besides Australia. The practicability of producing motor fuel from molasses has recently been investigated by a Special Committee appointed by the Hawaiian Chemists' Association at Honolulu. Already one distillery has been established for the manufacture of alcohol for use as a fuel, and it is asserted that the results obtained have shown conclusively that, if the molasses from all the sugar mills in the island were used for that purpose alone, it would be sufficient to meet all Hawaii's demands for motor fuel. In the *Bulletin* issued by this Institute on power-alcohol, it is pointed out that, if the whole of the 10,000,000 gallons of molasses which are produced annually in Queensland were used for the distillation of alcohol, the yield would be 4,100,000 gallons. From the economic point of view, the main difficulty is to get a sufficient quantity of molasses collected at one centre for distillation; but, until the existing Excise duty of 1s. a gallon is removed, there is no possibility of developing the industry in Australia so as to compete successfully with petrol.

POWER-ALCOHOL INVESTIGATION OFFICERS.

It is announced that Colonel Sir Frederic Nathan, K.B.E., late R.A., has been appointed Power-alcohol Investigation Officer, under the Fuel Research Board of the Department of Scientific and Industrial Research. The appointment of this officer has been made as a result of the consideration given by the Committee of Council for Scientific and Industrial Research to the report of the Inter-departmental Committee on the Production and Utilization of Alcohol for Power and Traction Purposes, which recommended the establishment of a small permanent organization, under the Department of Scientific and Industrial Research, to continue investigations into these problems. The Fuel Research Board proposes to begin by bringing the work already being done, both as regards production and utilization of alcohol, into proper focus. Sir Frederic Nathan, who, before the war, was Superintendent of the Royal Gunpowder Factory, at Waltham Abbey, and later, Works Manager of Messrs. Nobel's explosives factory, Ardeer, was the officer in control of alcohol under the Ministry of Munitions during the war, and Chairman of the Production Section of the Inter-departmental Committee above referred to. He has been intrusted with the survey of the present position, and with making proposals to the Board for such experiments and research as may from time to time appear to be necessary. Professor Pierce Purcell, who was Secretary of the Irish Peat Inquiry Committee, has also been appointed to act as Peat Investigation Officer under the Fuel Research Board. The duties of the Peat

Investigation Officer will similarly be to keep the Board informed of all progress in connexion with research into the utilization of peat, to continue and extend experiments on the mechanical cutting and winning of peat, and to make arrangements for tests of the use of peat as a fuel under boilers.

POWER-ALCOHOL FROM SAW-MILL WASTE.

In an article on power-alcohol which appeared in the last issue of this journal, attention was drawn to the manufacture of alcohol from saw-mill waste, and it was stated that up to the present softwoods only have been used for the purpose in America. The Forest Products Laboratory, Madison, U.S.A., has recently completed a comprehensive inquiry on the whole question, and advance figures have been received showing the yields of spirit obtainable from various timbers. These are shown in the following table:—

ALCOHOL FROM WOOD-WASTE.

Yields from different Timbers in United States of America.

Softwoods.		Hardwoods.	
Species.	Yields in Imperial gals. (95 per cent. spirit) per ton, allowing 5 per cent. Distillation Loss	Species.	Yield in Imperial gals. (95 per cent. spirit) per ton, allowing 5 per cent. Distillation Loss.
Idaho White Pine	21·87	Birch	12·05
Red Spruce	21·32	Hard Maple	8·53
,, ...	22·41	Silver Maple ..	13·13
Douglas Fir (Montana) ..	19·22	Beech	5·62
,, (Wash.) ..	22·35	White Oak	11·56
White Pine	21·07	Red Oak	7·53
Long-leaf Pine ..	23·23	Sycamore	9·03
,, ..	23·48	Slippery Elm ..	5·58
Lodgepole Pine ..	20·30	Redgum	10·29
Norway Pine	21·82	Cottonwood	6·73
West Larch	14·03		
,, ...	24·46		
,, ...	19·53		
West Hemlock ..	22·47		
Sugar Pine	17·67		
,, ...	20·04		
White Spruce	24·06		

Further information, with comments and interpretation of the above results, will be published in the *American Bulletin*, which is to be published shortly on the matter; but at present further particulars cannot be given. It will be seen that the yields obtainable from hardwoods are much lower than those from softwoods. With the facilities and resources at its disposal, it has not been possible for the temporary Institute to carry out any investigations on the yields of alcohol obtainable from Australian woods. The question is one of undoubted importance, in view of the enormous quantities of timber wasted in this country. It is one of the many urgent problems awaiting investigation by the proposed Forest Products Laboratory.

LIQUID FUEL AND FUEL ECONOMY.

The unsatisfactory position of Australia in regard to her liquid fuel requirements has frequently been pointed out. From the defence point of view alone, the situation is extremely serious, since the carrying on of motor transport and aviation is entirely dependent on imported fuel. The proposal to manufacture power-alcohol has been exhaustively inquired into by this Institute from a scientific and technical point of view. The question of the benzol industry in Australia has been reviewed by Mr. V. G. Anderson in a series of articles which recently appeared in the *Industrial Australian and Mining Standard.* The question as to whether we could produce sufficient benzol to supply our domestic requirements of motor spirit is answered by Mr. Anderson in the affirmative, that is, provided the whole output of coal in New South Wales is carbonized in by-product coke ovens or retorts and the benzol is saved. English and American experience over long periods has shown that from 2 to 3 gallons of benzol can be recovered per ton of coal. In Australia, using a blended mixture of coal from different fields, we would expect to get, at least, 17,000,000 gallons of benzol from 8,500,000 tons of coal. The approximate value of the products obtainable from 1 ton of coal carbonized in by-product coke ovens is estimated by Mr. Anderson at 17s. 4d.; and, in addition to this, 14 cwt. of coke would remain. This is very considerably more than the cost of the coal at pit's mouth, which averages about 12s. 6d. per ton.

UNITED STATES OF AMERICA BUREAU OF STANDARDS.

A report has recently been issued on the work of the Bureau of Standards at Washington for the year ending the 30th June, 1919. The Bureau is organized in 64 scientific and technical sections, and twenty clerical and operative sections. During the year, the Bureau issued 51 publications, not including reprints, 36 of which were new, and fifteen revisions of previous publications. In the various laboratories of the Bureau, more than 131,000 tests were made during the year. The funds made available for the year amounted to, approximately, £600,000. A noteworthy event of the year was the completion of the industrial laboratory, in which will be housed the divisions having to do with researches of structural timbers. The building also includes a commodious kiln, for the use, among other apparatus, of the ceramics division for the experimental production of new clay products and other general investigational purposes.

NEW METHOD OF DEHYDRATING FOOD.

Meats, eggs, vegetables, and fruits can now be dried in a manner which preserves their original properties and nutritive value and still have an appearance of freshness when prepared for the table. Although in former years there were dried fruits and vegetables that had a fine appearance, it was often found that they had been treated with sulphites and other materials, the use of which had been questioned by food experts. Dr. K. George Falk, of the Harriman Research Laboratory, Roosevelt Hospital, New York, explained the new methods in an address before the New York Section of the American Chemical Society, of which he is a member. He announced that, following the

experimental stage in this process, meats and vegetables had been thoroughly dried in the Industrial Chemistry Laboratory of Columbia University under the supervision of Professor Ralph H. McKee, and had been shipped to different parts of the world, where they have been used with success. One consignment of the meat dried in this manner gave great satisfaction in Armenia, where it was distributed by the Near East Relief Fund. Other products of the new dehydration process had been taken to distant parts of the world by exploring parties, and had been found to answer all the requirements.

Dr. Falk said that from these meats and other foods which were dried in a vacuum delicious dishes could be made, the taste of which would commend them to any housewife. From the dried meat, savory stews and hashes are made, while the vegetables which may be incorporated with the meat have as fine a flavour as if they had only recently come from the garden. It would be possible by means of this process to dry beef in vacuum ovens in parts of the earth where cattle may be raised very cheaply, as in Argentina, and to transport the dried product for many thousands of miles at very low freight cost. As canned fruits contain considerable moisture and are placed in metal containers, the advantages of the vacuum-dried products become manifest, according to the view of Dr. Falk. "Transportation," said he, "has always been a question of vital importance. Ships and other common carriers are always at a premium, and, again, certain kinds of food require special equipment, such as cold storage. For example, the plentiful supply of sheep in New Zealand might benefit the rest of the world to a greater extent if more transportation facilities were available." Dr. Falk said that usually sun-dried meats and other foods were discoloured, and that their nutritive values were impaired. While even with fairly good methods of dehydration it would have been found necessary to use bleaching agents, a recourse which was not required, according to the process developed at the Harriman laboratories. The incentive to develop this method of preservation for food products was given early in November, 1917, by Colonel John R. Murlin, in charge of the Division of Food and Nutrition of the United States Army, and was developed by Dr. Falk, Dr. Edward M. Frankel, and Professor Ralph H. McKee.

ADVANTAGES OF VACUUM DEHYDRATION.

"In the dehydration of meats," Dr. Falk pointed out, "the temperature must be kept below the point at which the proteins coagulate, for if there is too low a temperature the process of dehydration will be unnecessarily prolonged, with the result that often spoilage will occur, and the overhead cost will be greatly increased. It is possible to solve this problem of dehydration by the use of a suitable vacuum drier, in which the meat or other food product is introduced, in pieces of suitable size, and kept in the vacuum at a temperature which is below that of cooking, or which makes no appreciable change." Dr. Falk said that a large variety of foods had been dehydrated by the vacuum method, and that a number of others will probably be subjected in time to the same process. The mechanism used is not complicated, and can be easily installed at remote places. "In considering food preservation methods in general, it may be stated," he said, "that such methods will come into use more and more." The Government estimated that 50

per cent. of the fruits and vegetables grown in this country never reach the consumer as a result of poor transportation facilities, irregularities in marketing, and other causes. At the same time, greatly because of recent work on such questions as food hormones, the tendency is to use fresh foods wherever possible. The newer dehydration processes approach more nearly the requisite standards of fresh foods than do the older methods of preservation. The whole question is in a state of development. Dehydration offers the most promising outlook for the future. Air dehydration marks a great advance over the older methods of food preservation, and it would appear that vacuum dehydration possesses, in its turn, advantages over air dehydration.—(*Journal of the Franklin Institution,* Vol. 189, No. 1, January, 1920.)

GAS-MASKS FOR INDUSTRIAL USE.

The gas-mask is rapidly finding its proper place in the industries. Experience has shown that it has a wide application in protecting workmen from the noxious gases and fumes given off in many chemical operations. In rubber factories, gas-masks could be used around volatile solvents, such as carbon disulphide, carbon tetrachloride, sulphur chloride, and certain organic accelerators. In allied chemical plants they give good protection in pyrite smelting and roasting operations wherever sulphur dioxide or oxides of nitrogen are encountered. The war gave great impetus to the development of better gas-masks, and the United States of America Bureau of Mines has established a gas-mask department at its Pittsburgh Experiment Station, where masks of the army type are being developed for industrial use. The matter has already been taken up by this Institute in collaboration with a Committee of the Broken Hill Mine Managers' Association, and a number of the latest type of box respirator masks is being obtained for experimental purposes.

NEW SUGAR CANE PESTS.

Supplementary information to that which has already been published by the Queensland Bureau of Sugar Experiment Stations dealing with lepidopterous pests has recently been printed in *Bulletin* No. 9. The bulletin has been prepared by Mr. Edmund Jarvis, Assistant Entimologist to the Queensland Government. Four of the insects described affect cane in other countries, and two of them—which happen to be closely related to the destructive "Army worm" (*Cirphis unipunctata*)—at times cause sufficient injury to compel growers to take repressive measures. In addition to describing early-life stages, the writer has prepared lists enumerating a number of lepidoptera allied to the insects under consideration that affect cane elsewhere, reference to which will enable readers to determine at a glance indigenous species that may prove hurtful to this crop in the future, together with those whose possible introduction into Australia is undesirable.

CONTROLLING THE CORN WEEVIL.

The Marion County, Florida, agricultural agent, co-operating with the Bureau of Entomology's field agent in Florida, reports his most valuable work to be controlling the corn weevil. During the current

season, approximately 850,000 bushels of corn were raised in his county. The agent held a series of meetings, and gave illustrated lectures about the evils and control of the corn weevil, with the result that a great many farmers have built air-tight cribs for the proper housing and fumigation of their corn, and, as a direct consequence, many thousands of bushels of corn have been salvaged. The *Weekly News Letter* states that an air-tight crib large enough to store a reasonable amount of corn is the first essential in combating the weevil. It is also necessary that the corn be thoroughly dry, to prevent heating, before it is placed in the cribs for fumigation. The best results usually follow where the husks are removed from the corn, so that the grain can be placed in an open crib for a period of ten to fifteen days, where it will have access to plenty of light and air. This also operates to free the grain from the weevil, which cannot withstand light, especially sunshine. After the corn is thoroughly dry, it should be placed in an air-tight crib, and 4 lbs. of carbon disulphide should be applied for each 1,000 cubic feet of space in the crib. If the shucks are not removed, the quantity should be doubled. The application should not be made on damp and rainy days, as too much moisture prevents speedy evaporation. A second fumigation should be performed within 25 to 30 days after the first. Ordinarily, two fumigations are sufficient to save the corn crop, although it is essential to watch the grain closely thereafter, and, if necessary, to make use of the carbon disulphide treatment a third time.

HIGHWAY WORK IN THE UNITED STATES OF AMERICA.

Delayed in its programme of good roads construction by the war, and confronted at the end of that period by a condition of badly run-down highways, the Federal Government of the United States of America, co-operating with the highway departments of the several States, has resumed the vigorous prosecution of the work, and, states Mr. David F. Houston, Secretary of Agriculture, there is now no special obstacle to the construction, in the different States of the Union, of those roads which serve the greatest economic needs. In his annual report, Mr. Houston writes:—"Good roads are essential to the prosperity and well-being of urban and rural communities alike. They are prerequisite for the orderly and systematic marketing of farm products, for the establishment of satisfactory rural schools, and for the development of a richer and more attractive rural life." Recognising these facts, the Federal Government, through the passage of the Federal Aid Road Act in 1916, inaugurated a policy of direct financial participation in road-building operations in the various States. This Act appropriated \$75,000,000, to be matched by an equal amount from the States, for the construction of rural post roads over a period of five years, and \$10,000,000—\$1,000,000 a year for ten years—for roads within or partly within the national forests. It required each State to have a responsible central highway commission with the requisite powers and funds. All the States have complied with the terms of the Act, although it was necessary for them to enact additional legislation or to amend their constitutions, to provide sufficient funds to match the Federal apportionment, and to strengthen existing central highway bodies or to create new agencies.

ROAD WORK AFTER ARMISTICE.

When these preliminary steps had been practically completed, and the Department and the States were about ready to proceed vigorously with the actual construction of roads, the United States entered the war. It soon became necessary greatly to curtail highway building because of the difficulty of securing transportation, construction materials, and the requisite services. After the armistice was signed, arrangements promptly were made for the active resumption and vigorous prosecution of road work in all sections of the country, not only with a view to repair the damage wrought by the heavy traffic forced upon their highways during the war, when maintenance operations were seriously interfered with, but also to provide adequate transportation facilities to serve the increased needs of agriculture and industry. Recognising also that road-building activites would furnish suitable employment for many unemployed men during the period of transition from war to peace, the Congress, at its last session, accepting the recommendation of the Department of Agriculture, appropriated \$209,000,000, in addition to the \$85,000,000 provided by the original Act, for the extension of road construction in co-operation with the States, and also made some important amendments to the Act. The definition of the kind of roads that can be constructed was greatly broadened, and the limitation on the Federal contribution for any one road was increased from \$10,000 to \$20,000 a mile. These amendments, it is stated, have greatly facilitated consideration of, and action upon, the road projects submitted by the State Highway Commissions. There is now no special obstacle to the construction in the different States of the Union of the roads which serve the greatest economic needs.

FUEL ECONOMY--BY-PRODUCTS FROM LIGNITE.

Important progress is being made in Canada in investigating the possibility of obtaining valuable volatile products by the carbonization of lignites—low-grade coals of which there are large deposits in the Prairie Provinces. The problem of coal-supply in southern Saskatchewan and Manitoba is serious, and though there are large available supplies of lignite, they contain over 30 per cent. of moisture, and their calorific value is less than 4,000 calories per gram. The carbonization experiments were divided into small-scale laboratory tests, large-scale laboratory tests, and semi-commercial tests, the primary object of the investigations being, not to design a commercial plant, but to obtain the accurate data essential for the scientific design and control of such a plant.

Results of the small and large scale laboratory tests have recently been published in the Report for 1918 of the Mines Branch of the Canadian Department of Mines, but information regarding the semi-commercial tests is not yet available. As regards tar-oils, the best results were obtained with slow heating, at a temperature of about 550° C., the yield being about 5.9 gallons per short ton of moist coal as charged. This gave a carbonized residue of 890 lbs., together with 10.4 lbs. of ammonium sulphate, and a gas yield of 2,750 cubic feet.

The highest yields of ammonium sulphate were 16.8 lbs. per short ton, obtained with rapid heating at from 750° to 800° C.; 11.5 lbs. of ammonium sulphate; 5 gallons (Imp.) of tar-oils; and 870 lbs. of carbonized residue having a calorific value of 12,400 B.Th.U. per lb.

FARMING SCHOOLS IN EUROPE.

Something of the character of reconstruction work going on in agricultural districts of Italy can be gained from data recently compiled by the States Relations Service of the United States Department of Agriculture concerning the itinerant agricultural instruction of that country. According to the latest statistics, the farmers of Italy have had the benefit of instruction from 278 agricultural professors, who travel through the country giving short courses, which are both theoretical and practical in character. The cost of this work is approximately £80,000 a year. This expense is shared by the State, the province, and some local organization. Thirty-eight of these itinerant professors specialize in such subjects as cheese making, silk-worm raising, mulberry culture, viticulture, fruit culture, and plant diseases. Since the close of the war, many courses have been conducted in farm mechanics to instruct farm labourers in the use and repair of farm machinery. Courses in farm bookkeeping for young men and women have also been contemplated.

PAPER YARNS—DEVELOPMENT IN GERMANY.

The uses to which paper yarns were put in Germany during the years of the great war are manifold, and the ingenuity shown therein is worthy of admiration. Paper string is well known nowadays, but the Germans have used, and still continue to use, paper yarns for sacking, mats, carpets, table covers, dress stuffs for house wear, and for aprons, curtains, casement cloths, and even for suitings, underclothing, &c. As things are getting more normal, and cotton yarn can now be obtained in Germany, naturally a good many of the uses to which paper yarns were put have now been abandoned, but apparently a good number of the articles have, so to speak, come to stay.

The *Textile Mercury* states that, when travelling in Germany to-day, the observant man or woman will notice that many of the seats in first and second class compartments have been re-covered with a material woven from paper yarns, and it must be said that in most cases one gets the impression that the material is likely to prove very serviceable, although it is, of course, harder and more brittle than the plush or velour formerly used. Paper suitings, underclothing, &c., are already out of date, and almost unsaleable, but mats, carpets, and more especially printed paper-woven material for casements, curtains, and for many decorative purposes still find a ready sale, and will likely do so for years to come, as they are much cheaper than cotton goods.

Paper window curtains, printed to give the effect of tapestry, and decorative stuffs, are very much in vogue, as are also carpets, stair-casings, &c., and these will be valuable for a long time yet, as they have been proved to be very serviceable. The designs for decorative stuffs

are mostly small, flowery patterns, with short repeats, and in neat, as a rule, dark colours, all glaring colours being eschewed. These decorative stuffs can be bought to-day in the shops at 4 marks per metre, 30 inches wide; or, at the present rate of exchange, at about 6d. per yard. Plain material, unprinted, as used for coarse aprons, &c., costs, the same width, 2d. to 3d. per yard; and small finished aprons, with one pocket, can even be bought for from 2 to 3 marks, or 3d. to 4d. each.

The main drawback as regards this kind of material is its stiffness and liability to break when crumpled or creased. Naturally, also, it cannot be washed in the ordinary way, but must be cleaned with soap and cold water, and scrubbed with a not too hard brush. Numbers of women of the working class wear skirts made of paper material, and on the whole they appear to wear well, and they cannot, without close examination, be distinguished from cotton material.

SHEEP FEEDING EXPERIMENT.

The practice of artificially feeding sheep during long periods of dry weather has not yet become general in Australia, because it is generally regarded as being too expensive. A series of experiments carried out by Mr. G. L. Sutton, Agricultural Commissioner for the Wheat Belt of Western Australia, disposes, however, of this objection. His object was to ascertain whether an animal could be maintained in a healthy condition for four or five months on chaffed hay alone, there being no intention of attempting to fatten the sheep or prevent it losing some condition. Summarized, the conclusions to be drawn from the three experiments are:—

(1) That sheep, not in lamb, and averaging about 80 lbs., can be kept in a thrifty condition during the summer on 1 lb. of good chaffed hay per day.

(2) That larger rations are not warranted when the object of hand feeding is to carry sheep over a limited period from a time of scarcity to one of plenty.

(3) That a daily ration of ⅜ lb. whole oats is not of itself sufficiently bulky unless coarse feed is available.

(4) That in-lamb ewes (80-90 lbs.) can be carried over during the summer months in a thrifty condition on ⅜ lb. whole oats provided they have access to stubble straw.

(5) That if the production demands, due to lamb bearing, are to to met by the food supply, a ration of 1 lb. chaffed hay will require to be supplemented with oat grain.

(6) That feeding oat grain influences the production of bigger and stronger lambs.

(7) That when the sheep are entirely handfed, the ration should consist of a mixture of chaffed hay and grain, and if a ton of chaffed hay can be purchased or produced at half, or less than half, the cost of a ton of oat grain, it can economically form the bulk of the ration.

(8) An ample supply of salt should always be provided for sheep on stubbles or other bulky dry feed.

EDITORIAL.

THE EMPIRE'S COTTON INDUSTRY.

Frank recognition of the serious position of the cotton industry is shown by the emphasis given to a number of important proposals submitted by the Board of Trade Committee, which was appointed to investigate the best means of developing the growing of cotton within the Empire. Since 1917, as is well known, the situation was bad enough, but it has become annually much worse. Owing in part to the necessity for growing more foodstuffs to meet the needs of the country, the cotton crops in the United States and in India have been curtailed, and on top of this, the seasons have proved unfavorable; so that there is now a very large world's deficiency. According to the *Board of Trade Journal,* which publishes a summary of the Special Committee's report, the Committee is confident that if proper measures are taken, it should be possible to grow within the Empire, at any rate, a very large proportion of the cotton it requires. Moreover, the Committee is firmly convinced that in many parts of the Empire cotton growing will greatly increase the prosperity of the Colonies which grow it. Discussing the problem generally, it was pointed out that the solution appears to depend upon the proper handling of three main questions—(1) The acquisition of necessary knowledge, and the supply of men to apply that knowledge; (2) the establishment of efficient arrangements for controlling the growing of cotton crops, and marketing the crops when grown, so as to secure the best results for the growers; and (3) the provision of the necessary funds. The establishment of a Central Research Institute is the first recommendation. Research is required, not only into the true relation between the characteristics of cotton lint and the qualities of the finished article, but is also urgently needed into the principle underlying the growth of cotton. Two branches of research are therefore required—one into the laws of heredity and their application to the development of cotton; the other into the effects and limitations of environment.

COTTON RESEARCH.

The Empire Cotton Committee lays very great emphasis on the need for making great additions to the Agricultural Departments of all British Colonies and Dependencies, particularly where cotton can be grown, and the need for pioneer work is discussed. Three classes of officers at least are required: men of outstanding ability to conduct pure research, men of good scientific qualifications for direct investigations, and practical men for pioneer work, and for bringing influence to bear on ordinary agriculturists. These classes are additional to administrative and executive officers necessary to secure proper control of the cotton crops under the regulations laid down by the local authority. In view of the need for so many highly trained men, the Committee points out that there is a preliminary need to be supplied, and that it is advised by competent witnesses that provision must be made for more pure research to be done at British Universities, and other place, in such subjects as Plant Physiology, Plant Genetics, Mycology, and Entomology. At least one professorship or readership in each of these sciences should be provided. In addition, provision should be made for a number of

post-graduate studentships attached to these and other chairs, by means of which promising men can be trained in methods of research. The Committee has made a small beginning by having arranged with the British Cotton Industry Research Association to co-operate in offering five such studentships, to be held in the coming year. The Committee recommended the Government to take this matter into serious consideration in consultation with the cotton industry, and many others which depend on agricultural products for their raw materials; and it also recommends that liberal contributions for this purpose should be recognised as part of the expense of increasing the cotton supply.

THE MARKETING OF COTTON.

Economic considerations are discussed in addition to questions of scientific research, and the Committee explains that, in the infancy of cotton development in any new district, special arrangements are necessary to secure to the grower prices proportionate to the quality of his cotton. It is also pointed out that financial assistance must occasionally be afforded during the period of growing. This may sometimes take the form of fixing prices ahead, in others, it may be necessary to make monetary advances against the crop. For all such work, it is felt that some agency independent of Government will be needed; and it is recommended that an agreement should be made with the British Cotton-growing Association, subject to that body foregoing commercial profits and being guaranteed against loss on this part of the business. It is, in the first place, pointed out that, apart from the large capital required every year to finance and market the crops, promotion of cotton-growing will involve the expenditure of a good deal of money. Some forms of expenditure have already been indicated. There are also many other matters, often of pressing importance, for which a large amount of money will eventually be required. The great need in almost every Colony or Protectorate is for better transport facilities. Roads, railways, water communications, and harbour works, are almost everywhere demanded. There are also, in many places, present or prospective needs for irrigation and drainage.

ELECTROLYTIC TREATMENT OF SEEDS.

An important announcement is made by Dr. Russell, Director of Rothamsted Experimental Station, upon the treatment by an electrolytic process of the seeds of various farm crops. Discussing the Wolfryn process, he states that the cost of the treatment in the case of wheat seed is about 28s. per quarter, which works out at about 7s. to 10s. 6d. per acre, assuming the usual rate of seed of about 2 or 3 bushels per acre. In the *Journal of the Ministry of Agriculture* of January last, he states that up to the present agricultural experts have not been particularly enthusiastic about the treatment, because the samples of seed tested at colleges and experimental stations have in the main proved no better than untreated seed. Similar results have been obtained by certain farmers who have taken the trouble to weigh up their produce.

Experimental tests with treated seed made at Rothamsted in 1918-19 were made with oats and barley. In five out of eight cases tried there was no increase, while in some there was a loss. Of the other three cases, the slight gain of 3 per cent. is too small for any certainty as to gain to be reckoned; the other two gains might be real, but they do not in any case represent much. The experiment was repeated in 1919 with seven different lots of wheat, and of fourteen measurements in these seven different cases, only four were in favour, whilst eight are against the process. Dr. Russell also quotes another series of experiments made by Professor Somerville, at Oxford, which were a little more favorable, perhaps, than those obtained at Rothamsted, and they were also more favorable, than other results obtained on experimental stations; but they did not, according to Dr. Russell, hold out any particular promise.

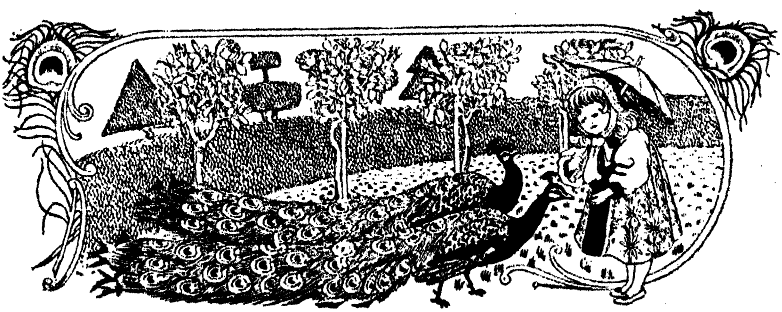
EFFECT OF ELECTRICITY.

Discussing the question generally, Dr. Russell points out that it may be that the successes are purely accidental; on the other hand, they may be real, and he is inclined to think that they are. The process consists of three parts: soaking the seed in a solution of certain salts; submitting while still in the solution to an electric current; then drying at 110° F. Now, it is well known that kiln-dried barley, especially after steeping, will germinate more evenly and satisfactorily than will ordinary barley. This is particularly the case if the barley contains any amount over 14 per cent. or 15 per cent. moisture, and it is also true even in a season when the moisture content is below the average. Professor Stapledon has shown that drying seed at 100° F. may improve its germination, unless germination is already very good. Anything that helps germination may be useful on land which has been folded and left in an unfavorable condition. It is possible that the drying in the treatment might be sufficient to help germination. Apparently, in some cases, the electrified seed made the better start. At Wye, the young plants from the electrified seed, both of oats and barley, at first showed greater vigour than those from untreated seed, but the superiority soon vanished. This, however, is not usual. At Rothamsted, no such difference was seen. In Professor Stapledon's germination tests, the treated seeds were not quite so good as were the untreated. Nevertheless, the occasional help to germination derived from one or other parts of the treatment may prove of value in certain field conditions, and thus lead to a better crop than would otherwise ensue. It is impossible to prove a negative proposition; a few unexceptional positive results outweigh any amount of negative evidence, and would show that the treatment had some merit. Dr. Russell therefore points out that the failure of electrified seed to give any increase in yield under the carefully-controlled conditions of an experimental station trial shows that the process lacks certainty. It cannot be compared in effectiveness with manuring, which succeeds nearly every time if properly done. He is not prepared, on present evidence, to say that the process never succeeds, but the risk of failure seems so great that the farmer should look upon it as an adventure which may or may not prove profitable.

SCIENCE AND INDUSTRY.

RESEARCH ON FOOD AND NUTRITION PROBLEMS.

The American National Research Council has formed a special Committee on food and nutrition problems, composed of a group of the most eminent physiological chemists and nutrition experts of the country, which will devote its attention and activities to the solution of important problems connected with the nutritional values and most effective grouping and preparation of foods, both of human and animal use. Special attention will be given to national food conditions and to comprehensive problems involving the co-ordinated services of numerous investigations and laboratories. The Committee, with the support of the Council, is arranging to obtain funds for the support of its researches, and will get under way, as soon as possible, certain specific investigations already formulated by individual committee members and subcommittees. These include studies of the comparative food values of meat and milk, and of the conditions of production of these foods in the United States, together with the whole problem of animal nutrition; the nutritional standards of infancy and adolescence; the formation of a national institute of nutrition; and other problems of similarly large and nationally important character.



Scientific and Industrial Research in the United States, Canada, and Australia.

By T. BRAILSFORD ROBERTSON, Ph.D., D.Sc.*

It is very surprising to note, after a sojourn of some years in America and in Canada, the extraordinary indifference of Australia to the lessons taught by the war in respect to the vital importance of higher education and research. In Europe, Asia, and America the war has completely transformed the attitude of the leading industrial States towards higher education and investigation. What all the warning words, propaganda, and precepts of our scholars and investigators for half a century had failed to do, the sharp demonstration of war effected within the brief space of five years. Research was discovered to the politician, not as the amiable weakness of elderly scholars, but as the mainspring of national industries and the arbiter of life and death in war.

So it happens that in America to-day money is being lavished upon research, particularly, of course, research of some immediate material value, "Industrial Research" so called, but not to the exclusion of the "pure" sciences from which are to issue the industrial discoveries of the future.

In the first place immense sums of money are now being expended by industrial firms in the United States on research, often along purely theoretical lines. Thus it is estimated by Dr. J. C. Fields, from data supplied to him by the firm, that the General Electric Company expended on research in its various laboratories in 1918 no less a sum than two million dollars (£400,000). The Eastman Kodak Company employ a staff of forty research workers, and its research laboratory costs thirty thousand pounds per annum to maintain; as much, it may be pointed out, as the entire annual expenditure of the University of Adelaide, which is expected, by this expenditure, to dispense the totality of human knowledge, from classical literature to surveying, to some six or seven hundred students annually. The Western Electric Company employs three hundred research workers, and expends for this purpose two and a half million dollars annually. The Dupont Explosives Company employs in its four chemical research laboratories two hundred and ninety workers, and expends two million dollars annually on research.

For what purpose, we may inquire, do these industrial firms expend such vast sums for the prosecution of scientific research? We may dismiss the idea that they do it for sheer altruism. That would not be "good business," and the directors of these firms are, it may be safely assumed, men possessed of sound business instincts. Mere display, or advertisement value, may be similarly dismissed, for the

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vast majority of their customers are ignorant of the fact that they expend money on research, and are, indeed, ignorant of what scientific research means. We are driven to assume that they do it because it pays, and pays most handsomely. Great indeed must be the reward which they have reaped from this policy, if firms in which business efficiency is carried to its utmost extreme are nevertheless willing to employ hundreds of men, and some at high salaries, to perform work the details of which they can but feebly apprehend, and which is not directly connected in any way with the daily output of the factory or the office.

To this the old-fashioned manufacturer has always two answers ready. The first is that he does do research—every manufacturing firm is seeking to improve its output, and that effort does, in fact, involve and constitute research. The second rather contradictory reply is that he has tried research, and it doesn't pay.

Both of these replies arise out of a total misconception of what modern scientific and industrial research implies. Profitable research, whether profitable in the material sense or for the sheer advancement of knowledge, is not to be done, nowadays, by untrained individuals, by people who have "picked up" a "practical" training in the works. A long preliminary training in research methods—in the technique of finding out new things—is an absolutely essential perquisite to success. The time has passed when fundamentally important industrial discoveries can be made by the lazy boy of the factory who ties two parts of a machine together with a piece of string, or by the operative who forgets to remove the fabric from the stretching machine overnight, and so discovers the process of mercerization. That day is past; it is Early Victorian, and it is extinct. To-day, as Pasteur has said, "Chance favours only the prepared mind."

Where are we to get these "prepared minds"? Obviously the only place from which they can come is the institution of higher training, the University. But do the students of our universities actually acquire training in the technique of finding out new things? And this leads us to the second objection, that the shortly-to-be-bygone manufacturer propounds, the objection that he has tried research, and that it does not pay. An incident which came to my notice while filling the Chair of Biochemistry at Toronto will serve to illustrate the origin of this objection. A certain individual had been recommended to a leading firm of manufacturers as a suitable person to conduct research, and the question of his appointment was, with unusual wisdom, referred to the Research Council of Canada. The reply chanced to pass through my hands, and it was to the effect that the Council did not recommend the appointment, because the man in question had not yet made a mark in research as a student in his University, and instances were numerous of failures and disappointment due to the employment of men "who have not cut their eye-teeth in this matter of research." That is the key to the whole difficulty. A chemical problem arises and a "chemist" is employed to solve it, irrespectively of whether he has ever "cut his eye-teeth" in the matter of research or not, and of course without any regard whatever to the question of whether the University in which he was

trained commanded the resources in staff and equipment to permit its students to "cut their eye-teeth" in research. Failure is the result and research is to blame. But the actual blame attaches to the manufacturer who chose a man for a special job with less inquiry into his fitness than he would have made into the fitness of a horse to pull his drays, and to the wealthy firms and citizens and legislators who permit their University to sink for lack of financial support to the level of teaching from the text-book and the lecture and the stereotyped laboratory "exercise," instead of leading its students to the borderland of the known and of the unknown and teaching them there to explore and to employ their knowledge for the practical ascertainment of new truths. Only men who themselves are masters of research-technique can teach this, and to be such men they must have time to think and work as well as teach, assistants to do the scullery-maids' work, which abounds in every laboratory, money to buy new and replace old apparatus, all over and above the necessary staff and funds for routine elementary teaching.

An amusing example of a "failure" of research is instanced by Dr. J. C. Fields in his article on "Industrial Research in the United States."* A group of firms engaged in chemical manufacture had collaborated to solve a problem which had arisen in their works. They employed "practical men" to work on the problem—men of long experience in handling their processes, but devoid of specific training in research. In this fashion they muddled away a hundred thousand dollars (£20,000) without any result whatever. It finally occurred to them to refer the matter to a trained chemist of well-known research ability. They came to him and stated that they were ready to spend a hundred thousand more upon the problem, and that they were willing to wait five years for a solution. Three research men were put to work on it, and the matter was speedily cleared up. The bill was four hundred pounds.

During the last session of the Federal Parliament, in the course of a debate upon the proposed Australian Institute for Industrial Research, a member is reported by the press to have inquired "whether we could point to a single pest eradicated from Australia by means of scientific research?" I am unable to answer this question, having been absent from this country, excepting as a visitor, for fourteen years. But if failures there have been, as I dare say may be the case, I will venture to assert that in the majority of instances the source of failure was not dissimilar to that illustrated by Dr. Fields. In others it may not impossibly have been due to the exaggerated estimate of the power of science of which the Australian public man would appear to be possessed. An Australian City Council, for example, has recently allotted the sum of twenty pounds for experiments upon the eradication of flies. It may be that the age of miracles is not yet past, as some of us are inclined to believe, but at all events this question will be settled—the age of miracles will assuredly be here—if the City Fathers are enabled, by the wizardry of science and the expenditure of twenty pounds, to arrive at a satisfactory method of eradicating this ubiquitous nuisance.

* *University of Toronto Monthly*, Scientific Research Number, vol. xix. (1919), p. 143.

SCIENCE AND INDUSTRY.

We who are citizens of our Commonwealth of Australia stand in a peculiarly hazardous position in the restless, over-populated world of our day. A handful of population scattered over the sea-fringe of the only empty habitable continent that remains. Clinging tenaciously to our sole right to populate this vast area of land, indisposed to invite others to share with us the burden and the reward, unshakably opposed to sharing either with Orientals. We stand alone with our small neighbour New Zealand facing starving hordes of Orientals, now rapidly arming themselves with the educational resources, manufactures, and death-dealing implements of Western civilization. The great centres of white population are twice the distance from us that our Oriental neighbours are, and they are subdivided and absorbed in mutual jealousies and suspicions. With these far-away friends who chance for the moment to regard our policies and our aspirations in a kindly or indifferent fashion—with this moral and potentially physical support, the continuance of which none can guarantee—we assert in no measured terms our absolute ownership of our great estate and debar our starving, overcrowded neighbours from participation in it. At the same time, we assert a high claim for leisure, for ease of circumstances and comfort of living, for short hours and high wages, comfortable sanitary dwellings, and elaborate expensive amusements. Our neighbours do without these things, and as they regard our riches and our comfort, our easy hours of work, and the infinite opportunities of our superabundant space, may they not be asking themselves, how long they shall starve while others have superfluity which they know not how to use, and a boundless estate which they know not how to populate?

We have, it is true, the priceless asset of our unsurpassable valour and of the memory of deeds which will be related with those of Thermopylæ and Marathon in the immortal records of humanity. But what will unassisted valour avail if it should ever chance that five million find themselves opposed by four hundred million? From odds of eighty to one backed by all the resources of a modern industrial civilization valour may not shrink, it is true, but prudence will seek allies.

Where shall we look for assistance? Not from without; our views, to others, may appear unreasonable, extravagant, even selfish. They have not to undergo the actual experience of invasion—they may not perceive our importance as we perceive it. Shifting policies, an international agreement, or a fresh world war may leave us morally and physically without external support. Only from within can we find assistance. Only in the wealth of our country, realized to its utmost extent. Our brains, our versatility, resourcefulness, and adaptability, qualities which distinguish the Australians above all other peoples, must find expression in the uttermost exploitation of our resources.

The mobilization of our intellectual forces is therefore the only avenue to salvation, and expressed in terms of daily existence, this means nothing more nor less than the utmost development of education and research. If one Australian is to accomplish as much as fifty Orientals in half their working day he must bring brains to his job, he must employ every known means of increasing his efficiency, and

he must discover more and ever more new ways of multiplying his powers. The function of science is the multiplication of the powers of man. Therefore we must be pre-eminently a scientifically trained and organized community.

Canada stands in a position of comparative safety, yet they have made far greater strides in this direction than we. The Dominion Council of Research and Industry is a living, intensely vital organization, re-organizing and re-creating the chemical and biological industries of Canada, and it is able to perform this complex task to the satisfaction of the whole community because it is endowed with large funds and still larger powers, and because its officials are men of the highest experience and training in scientific and industrial research. The proposed Commonwealth Institute of Research has, I understand, not yet been erected or endowed with suitable funds. I am totally unaware of the reasons for this backwardness of Australia because of my absence until recently from this country. But whatever the reasons may be, they should weigh as nothing against the reasons for immediately pushing forward the development of all branches and phases of research in Australia. We need research in our universities, and in every department of our universities, to train young men who will create our science and our industries of the future. We need research institutes in which to enable them to put their training and their knowledge into practice, and we need research laboratories in direct affiliation with our leading industries. Our stock-breeding must no longer be conducted haphazard, but under the direction of men trained in the principles of genetics. The by-products of our meat industry must no longer be disposed of as scanty experience dictates, but worked up into products of great value through the services of trained biochemists. Our farmers, like the new generation of farmers in California, must be University-trained men with a small and handy soil laboratory on their own premises, and in constant touch with University and Government Departments of Agricultural Research. Industrial firms should appoint fellowships to work out their problems for them in well-equipped laboratories in the universities, or in laboratories established for this purpose by the Commonwealth or State Governments. If we are to surpass Japan, we must keep level with Canada and the United States in the matter of modern industrial development, and none of these things can be started too soon.

It is useless to plead our poverty. Everybody is poor, Canada not the least; yet Canada can afford to spend a few millions on research besides maintaining several universities equipped to the highest standard. We spend money upon those things which we consider to be essential, while Japan is spending ten million yen (one million pounds) on a research institute for physics and chemistry alone. The plain fact of the matter is that we are, by our neglect and delay, deliberately placing ourselves in a position of the utmost danger, from which we can only be rescued by immediate and energetic action.

Tannins from Wattle Bark.

Results of Investigations in New South Wales.

The leather industry is one of the most important secondary industries in Australia, and there is little doubt that it will become even more important when tanning is placed on a more scientific basis. One essential is the supply of tan bark. For many years the bark used in Australian tanneries has been obtained mainly from two species of wattle—the golden wattle (*Acacia pycnantha*) of South Australia, and the black or green wattle (*Acacia decurrens*) and its varieties. As a result of the gradual destruction of wattle trees the Australian supply has become inadequate, and has been largely supplemented by wattle bark imported from Natal, where plantations have been formed by the utilization of Australian seed. In addition to the wattles, a valuable tan bark is yielded by the mallet (*Eucalyptus occidentalis*) of Western Australia, but though the useful properties of this bark were only discovered in 1903, its exploitation was so rapid that only comparatively small quantities now remain.

It is obviously a matter of great importance to insure a local supply of tannin for the future, and four possible means of doing this have been suggested, viz.:—

(*a*) *Regulation of bark collecting to prevent the destruction of young trees.*—Regulations on this matter are in existence in most of the States, but are difficult to enforce owing to the large areas and the small staff of the Forestry Departments.

(*b*) *Plantation of wattles for the production of bark.*—Many such plantations were established over 30 years ago, when estimates of prospective returns were published which made the industry look attractive, but experience has shown that owing to the slow growth of the trees and the danger from bush fires, wattle plantations are not generally successful in Australia from the industrial point of view.

(*c*) *Discovery of new sources of tannin.*—The Institute has collected information as to analyses of barks of Australian trees. The barks of about 150 species have been analyzed as to their tannin content, and 15 of them been found to average over 20 per cent. of tannin. Of these, nine are wattles; but except for the two species already mentioned, they are not very abundant. Two are Cypress pines, and one of these (*Callitris calcarata*) is a plentiful tree in the eastern parts of Australia, and is utilized to some extent. Three are mangroves, but the bark from these trees has hitherto not been utilized to any extent in Australia, owing to the fact that it imparts an undesirable red colour to the leather. This problem is being investigated in Queensland by the Institute, and a method of decolourization has been devised. The remaining species is the mallet referred to above. In addition, the kino (gum) produced by the redgum of Western Australia (*Eucalyptus calophylla*) contains a high percentage of tannin; but, as in the case of the mangrove, the leather tanned with this kino is stained a red colour. The redgum is very abundant in Western Australia, and has the peculiar advantage that the kino can be scraped off and collected without injuring the tree. The Institute is investigating the problem of its decolourization.

(*d*) *Manufacture of tannin extracts.*—This is another promising solution of the shortage of tanning materials, as it allows of the utilization of leaves, twigs, &c., as well as of barks containing too little tannin to be used directly. It would avoid the great amount of waste involved in the present methods of collecting wattle bark, in which the tree is cut down and the bark stripped from the trunk whilst the smaller branches and twigs are not utilized. Extracts have been prepared from wattle twigs, &c., by several Australian firms, but one of the difficulties is that gums and dyes are also extracted in the process, and the extracts have to be decolourized, whilst the presence

of the gums is objectionable. Before the war large quantities of Australian barks, including those of wattle, mallet, and mangrove, were utilized in Germany for the production of extracts, and these German extracts were imported into Australia. Chemical research in Germany had solved the problems of decolourization and of the removal of undesirable gummy matter, and these problems should be investigated in Australia.

In the early stages of their work, the Executive Committee of the Institute obtained a report from the New South Wales State Committee on the tanning industry in that State. In that report attention was directed to the fact that at many of the New South Wales tanneries no attempt was made to determine the amount of tannin, or even of extract, in the tan liquors prepared, and no analyses were made either of the original bark or of the spent bark. The proportion of bark and water used was not weighed or measured, and the water was in some cases used cold, in others hot, whilst in the latter the exact temperature was not determined. The tanners rely on the appearance and taste of the liquid, with the result that a great deal of time and material is often wasted before the required liquor is obtained.

It is true that in some few tanneries in Australia chemists are employed to analyze the barks, and, to some extent, to control the tanning process, but in the great majority conditions are as above described. The tanners interviewed admitted that their methods left much to be desired, and that they would welcome any scientifically worked-out method of procedure which would enable them to obtain extracts of definite and uniform strength. The Institute therefore appointed a Special Committee to investigate processes of extraction of tannin from wattle bark, with a view to the determination of a standard and scientific method of procedure under practical conditions. The members of the Committee were Professor Fawsitt (chairman) and Messrs. B. Bailey, F. A. Coombs, F. B. Guthrie, and H. G. Smith. The experimental work was carried out at the Tanning Department of the Sydney Technical School by Mr. F. A. Coombs. A summary of the report of the Committee is given in the following pages.

Methods Adopted in the Investigation.

(*a*) *Introductory.*—The primary object of this investigation was to obtain a more efficient method at Australian tanneries for extracting tannin from wattle bark. Two factors to be noted in connexion with this work are (1) that the Australian tanners require strong or highly concentrated liquors, and (2) that the tanners are at present using extraction plants constructed in accordance with their own ideas. Research then had to be conducted on lines that would not give weak liquors, the experimental plant being, if possible, constructed in such a way that it could be duplicated in the various tanneries without any costly alterations. Extraction processes, which included sprinklers or autoclaves, were not considered suitable for the extraction of tannin from wattle bark under the conditions described above.

South African patents cover a process which may give good results for the manufacture of extracts under local conditions; but for Australian requirements (especially in reference to extraction at the tanneries) it is necessary that the bark should be dry. The agitation of the bark during the extraction process may have certain advantages over a process which does not include this mechanical treatment, but only results covering a reasonable working period will give the value of this process, and, from the small amount of information available, it does not appear to have been found of any special value to Australian tanners.

The best plant for extracting tannin from bark at the tanneries is probably the "press leach battery." This may be described as the battery required for an open diffusion and continuous process. When the liquors are forced around the battery by gravitation we have what is generally called the "press leach system." Proctor and others have described this plant, and the former gives useful information which is directly related to the extraction process.

(*b*) *Experimental Processes as carried out by the Committee.*—Before the bark was placed in the extraction vats it was passed through a mill and reduced to the state known in the trade as "ground" bark. By grinding in a mill the tanner reduces the size of the particles of bark. Generally, the particles of

bark are reduced to the size which presents the greatest surface to the solvent, but which does not prevent percolation. Commercial ground wattle bark consists of coarse and fine particles, the latter being in a powdered state. If too much powdered bark be present it adversely affects the ordinary extraction processes by preventing percolation or uniform penetration of the water into the various layers of the bark. For ordinary extraction processes an amount of water is used which will just cover and yet completely penetrate the bark.

Powdered bark might well be expected to give the quickest and best results when used in a process which secures as complete as possible penetration of the water. This desirable result could be secured by any mechanical device capable of stirring or agitating the powdered bark, but in that case the amount of water used would have to be largely in excess of that volume required to just cover the bark. The bark used throughout in this work was that of *Acacia pycnantha*, commonly known in New South Wales as ground Adelaide wattle bark. Experiments were carried out to find, with this material, the difference between extraction with finely ground and coarse bark. Results from these experiments appear to indicate that under local conditions powdered bark has but little advantage over ordinary ground wattle bark, but this does not mean that less care can be taken when milling the latter. An ideal condition for extraction purposes would be obtained when the fibres of the bark are isolated but not reduced to a powder. Proctor, in his book, *The Principles of Leather Manufacture*, supplies much useful information on the grinding of bark. It would be difficult to teach our local tanners much about milling bark, but it may be said that a mill that is inclined to crush and shred the bark is better than one that only cuts and breaks it. Ordinary coarse-ground Adelaide bark as supplied to Sydney tanners was used for all the experiments described in this paper, and one could not find fault with the work done by the mill.

When wattle bark is covered with water the latter gradually penetrates the particles until these are thoroughly wetted. If the water is now allowed to drain away from the bark by gravitation it is found that a considerable amount is retained by it and cannot be completely removed even under a high pressure.

Our local tanners follow no definite rule as regards the time allowed for any one liquor to remain on the bark, but there is no doubt that in a number of cases they exceed to a considerable extent the actual time required for the result described above. Reduce this time, which may be called the "one liquor period," to a minimum, and the number of pits, &c., are kept at a minimum so far as this factor is concerned. The time for this one liquor period will decrease as the temperature increases and as the size of the uncrushed particles of bark decreases. It would also be expected to vary with different barks.

A number of tanners depend almost entirely on extraction at ordinary temperature, which is a variable figure, and attains its maximum in summer and minimum in winter.

In order to throw some light on the time for the one liquor period experiments were made which indicate that at temperatures of 11° to 15° C. twenty-four hours is a sufficient maximum time. The higher the temperature the less the time required, but good results are obtained at 40° C. in 3½ hours, 73 per cent. of the total tannins being extracted. If the time is extended to twelve hours at 40° C. this extraction is increased to 90 per cent.

Experiment with the Press Leach Battery.

After consideration of the results of the initial experiments, it was decided that the "press leach system" was the most suitable one for systematic experiment. Six jacketed copper vats, arranged in series, composed the battery. The capacity of these vats was 5,250 c.c. The water required to cover the dry bark was from 4,000 to 4,500 c.c., and each day 2,600 c.c. were drawn off.

The vat which received the fresh bark was called the "head" of the battery, and the vat containing the spent bark was called the "tail-end" of the battery. The spent bark was weighed immediately after it was taken from the battery, and it was then exposed for drying purposes. The six vats, for convenience, may be referred to as A, B, C, D, E, and F respectively. Spent bark was removed and replaced with fresh bark each day (Sunday excepted). Each lot of bark thus remained in the battery for a period of seven days. It is found in these experiments that determinations of the tannin in the liquors and in the spent

barks do not account for all the tannin in the original bark—a small percentage, apparently, experiences some chemical change. The tannin may itself change, or it may combine with some material in the bark.

PROCESS.

First Day.—The process was started by filling all the vats with bark, and then the bark in A was filled with 4,150 c.c. of water at 9 a.m.

Second Day.—At 9 a.m. the liquor was drawn off from A (at the bottom) as far as possible, and amounted to 2,600 c.c. This good tanning liquor was not returned to any of the vats. Immediately after taking off this liquor, 2,600 c.c. of water were added to vat A. At 1.30 p.m. another 1,550 c.c. were added to vat A, and this resulted in about 1,500 c.c. of liquid overflowing into B, which had been previously filled with bark. At 5 p.m. another 2,600 c.c. of water were added to A; this resulted in an overflow to B, which by this act was filled completely.

Third Day.—At 9 a.m. 2,600 c.c. of liquor were drawn off from B, and 6,750 c.c. of water were added to A, as described for the second day. At 5 p.m. sufficient water had been added to A to press forward the volume of liquor required to cover the bark in C.

Fourth Day.—2,600 c.c. of liquor were drawn off C, 6,750 c.c. of water were added to A, and the bark in D was thus covered with liquor.

Fifth Day.—2,600 c.c. of liquor were drawn off D, 6,750 c.c. were added to A, and the bark in E was thus covered with liquor.

Sixth Day.—2,600 c.c. of liquor were drawn off E, 6,750 c.c. were added to A, and the bark in F was thus covered with liquor. All the vats in the battery were now filled with bark and liquor. F was at the head and A was at the tail-end of the battery.

Seventh Day.—2,600 c.c. of liquor were drawn off F. All the weak liquor, approximately 2,600 c.c., was run off A (which now contained spent bark), and put on to the bark in B. The spent bark was removed from A, and A then received a fresh lot of dry bark. B received 1,550 c.c. of water at 1.30 p.m. and 2,600 c.c. at 5 p.m. A was now at the head and B was at the tail-end of the battery.

The process was continued on the same lines as laid down for the seventh day. Each vat only occupied the position at the head of the battery for one day. The 2,600 c.c. of liquor drawn off at the head of the battery at 9 a.m. each day was analyzed and the results shown for each experiment. The liquor from the spent bark replaced by gravitation the liquor removed at 9 a.m. from the head of the battery, and then a volume of water was used per day equal to that volume of liquor required to cover the daily quota of dry bark. This water was added in two portions—one at 1.30 p.m. and the other at 5 p.m. Loss by evaporation, slight differences in the size of the vats, and variations in the volume of liquid removed with the spent barks were responsible for slight changes in the volume of water used per day.

When the liquor for analysis was drawn off the last bark in each experiment there was still a considerable amount of tannin remaining in the battery, all the vats being filled with partially spent bark. No alteration was made in the volume of water used per day, and the resulting overflow liquors were collected and analyzed after they had passed through the last bark. These results are of special value, because they show the tannin and barkometer strengths of every liquor that passes through the last bark for each experiment. In some experiments these liquors were carried forward to the next one, and the total tannin is deducted.

With reference to the foregoing process, it will be noticed that—

(1) the total volume of liquor that passes through any one vat is proportional to the number of vats;

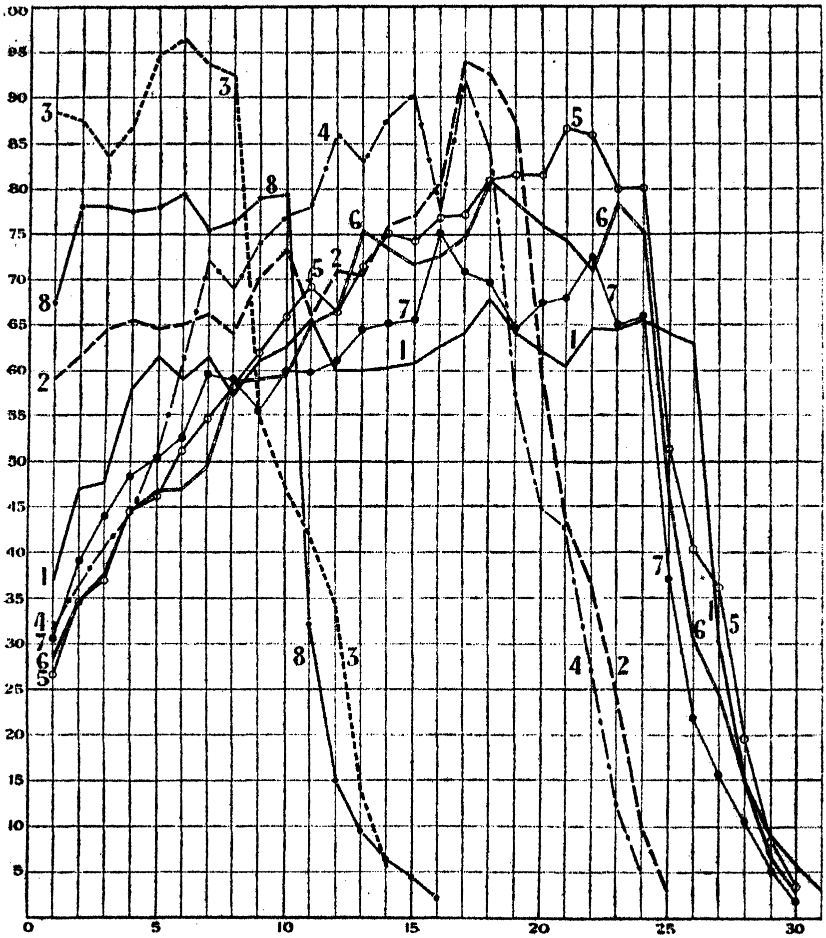
(2) the time covering the period that the bark remains in the vat is proportional to the number of vats;

(3) when the full time for the "one liquor period" is rigidly adhered to, the water required for the complete extraction of a given weight of bark will be at its minimum;

(4) as the volume of water used for the extraction of a given weight of bark increases, the number of vats required for the battery decreases.

If the volume of liquor drawn off each day is equal to the "outer solution" in the vat, then the volume of water used for the same period is equal to that volume required to cover the daily quota of dry bark. No attempt was made to control or influence the temperature of the first experiment with the press leach battery. The temperatures were recorded for the water as it went into the battery and the concentrated liquors as they were drawn off the bark.

The first three experiments were carried out without stopping the battery, and, therefore, a certain volume of liquors containing tannin was carried from the first experiment to the second experiment, and from the second to the third.



The base represents the number of days for which the several experiments were continued; the vertical heights show the percentages of tannins extracted.

third. A correction has to be made for this. The first experiment (No. 1, see diagram on this page) was continued for twenty-six days. The head vat was then corked up so that no liquor could flow beyond. The liquors were then drawn off at this vat and tested before passing them on to the first lot of bark required for the second experiment. In this way there was a complete barrier between the two experiments, and the amount of tannin which passed from the first to the second experiment was added to the first experiment and taken off from the second experiment. The same method was used for separating the second from the third experiment.

The percentage (64.1) of total tannin extracted from the bark in the first experiment was low. If the process was efficient the amount of tannin that could still be removed at ordinary temperature would be reduced to a minimum. This was tested by taking one lot of spent bark as it came from the battery and placing it in a separate vat with sufficient water to cover it. After twenty-four hours the density of the liquor reached 2° barkometer, and at the end of fourteen days it was 3° barkometer. The percentage of tannins in this liquor is low, but it could not be considered a negligible quantity. Spent bark from each experiment was tested at the temperature of the tail-end vat, from which the bark was taken.

In the second experiment (No. 2) the temperature of the tail-end vats was raised to 95° during the work-day. At first only the sixth vat was brought up to the high temperature, but this produced a strong liquor, which could not be sufficiently reduced by the water and liquor passing from it in one day. The fifth vat was then heated also. The results obtained from the second experiment show a considerable improvement on the first.

The third experiment (No. 3) was a duplication of the last part of the second. Two tail-end vats were worked at a temperature of 95° from 8 a.m. to 5 p.m. each day. This represents the working day. No liquor or water was passed forward during the night, when the temperature was allowed to fall to a figure which varies according to atmospheric conditions. The results obtained from this experiment were considered to be good: and a fourth experiment (No. 4) was considered necessary to confirm them.

The three next experiments (Nos. 5 to 7) only differed from the fourth as regards their temperature for the tail-end vats. These were kept at 80°, 60°, and 40° C. respectively.

For the last experiment (No. 8) all the vats were maintained at a temperature of 35° C. for the whole of the time required to complete the experiment.

In experiments Nos. 2 to 7 the hot liquors passing from the tail-end vats were responsible for an increase in the temperature of the fourth vat. The first three vats were allowed to remain at ordinary temperature for all excepting the eighth experiment.

Ground Adelaide bark was used for all the experiments. It is extremely difficult to obtain samples of wattle-bark containing the same proportions of coarse and fine particles. For this experiment the bark was passed through a sieve (twelve wires to the inch), and the proportions found for coarse and fine. Samples were taken from each and analyzed. The difference in tannin content between the fine and coarser particles did not amount to 1 per cent. of tannin on the weight of the bark. The daily quota of bark added to the battery consisted of 1 lb. of fine and 2 lbs. of the coarser particles. After careful sampling, a number of samples were made up, containing 3 lbs. of bark. At a later stage more samples were required, and the slight difference in the tannin values is due to the bark absorbing more moisture.

The following are the results obtained by analyses from two samples taken from bark used for the first three experiments*:—

Analysis of Bark used for Experiments Nos. 1 to 3.

Particulars.	per cent.
Tannin	37.55
Non-tannins	10.68
Insolubles	40.17
Water	11.60
Total	100.00

NOTE.—The numbers of the experiments in parentheses correspond to the numbers on the diagram on page 154.

* For footnote see next page.

The bark used for the remaining five experiments contained more moisture and less tannin, as shown below*:—

Analysis of Bark used for Experiments Nos. 4 to 8.

Particulars.	per cent.
Tannin	37.18
Non-tannins	10.58
Insolubles	39.78
Water	12.46
Total	100.00

In the following table results are given of the analyses of the spent barks:—

Analyses of Spent Barks.

Experiment.	Temperature of tail-end vats.	Tannin.	Non-tannin.	Insolubles.	Water.	Tannin calculated on original bark.	Total tannin in spent bark.
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
No. 1	20 to 25° C.	19·22	3·16	66·02	11·6	11·68	31·10
No. 8	35° C.	14·79	2·59	71·02	11·6	8·35	22·90
No. 7	40° C.	14·42	2·86	71·12	11·6	8·06	21·70
No. 6	60° C.	12·35	3·89	72·16	11·6	6·80	18·30
No. 5	80°	8·20	3·99	76·21	11·6	4·29	11·54
No. 4	95°	4·20	2·32	81·88	11·6	2·09	5·56
No. 3	95°	4·25	2·84	81·31	11·6	2·10	5·59

The extraction results are summarized in the next table:—

Extraction Results.

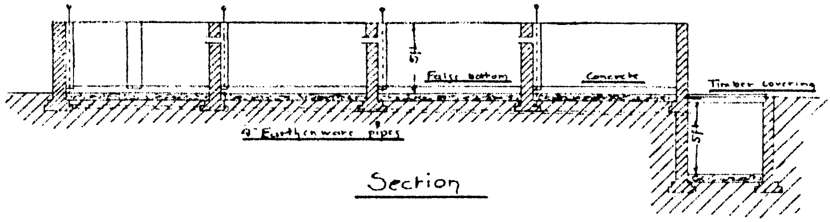
Experiment.	Temperature of tail-end vats.	Tannin extracted.	Tannin in spent bark.	Tannin lost.
		per cent.	per cent.	per cent.
No. 1	20 to 25° C.	64·1	31·1	4·8
No. 8	35°	74·35	22·9	2·75
No. 7	40°	74·1	21·7	4·2
No. 6	60°	79·48	18·3	2·22
No. 5	80°	84·82	11·54	3·64
No. 4	90°	90·8	5·56	3·64
No. 3	90°	90 6	5·59	3·81

Discussion of Results.

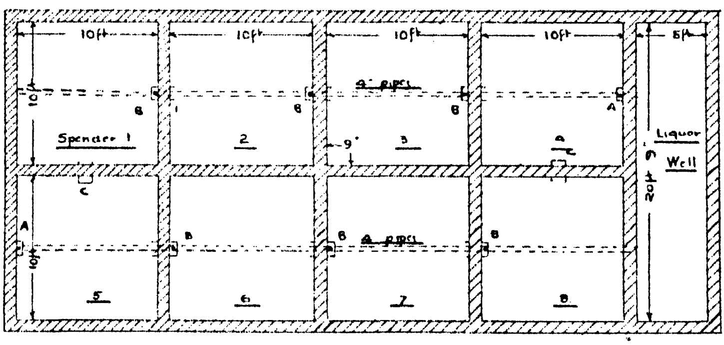
Six days were required to finish each experiment after the last lot of bark was placed in the battery, and the barkometer values are shown for each liquor as it passes from this bark. These figures can be taken as approximately correct for all the liquors passing from any one lot of bark when the battery is working under normal conditions. The battery is not working under normal conditions before the bark in every vat is covered with liquor. The barkometer values of the last liquors for the third and fourth experiments seem to indicate that all the tannin found in the spent bark was in a state of solution when this bark was removed from the battery, and, therefore, better results might have been obtained by adding more vats to the battery, or passing more water through the bark. However, a greater proportion of soluble non-tannin would have adversely affected the value of these liquors.

* It was extremely difficult to extract the last traces of tannin with one litre of water as per the standard method, and the total solubles are given for a further extraction amounting to two separate volumes of 500 c.c. each. The first 500 c.c. gave a total soluble of 1·14 per cent. and there was a slight reaction with gelatine. The second 500 c.c. gave a total soluble of 1·23 per cent. and no reaction with gelatine.

The proportions of non-tannin matters were always greater for the liquors at the head of the battery, and they reached a minimum in those tail-end vats that were not exposed to a higher temperature than 80° C. Prolonged exposure at a temperature of 95° C. is responsible for an excess of the non-tannin extracted from the bark. No explanations are required for using a battery worked on the press leach system. Reliable authorities have recommended this process, and, apparently, practical tanners in various parts of the world are satisfied that by gravitation the liquors can be forced around the battery without creating channels in the bark. A plan is shown for an eight-vat battery, where the bark would not be shifted from the time it first goes into the battery until it is removed as spent bark, and also one for a nine-vat battery, which will enable



Section



Plan

A. Plug. B. Plug and Overflow. C. Overflow Pipe. Scale, ⅛" = 1 ft.

the tanner to shift the bark once during the time it remains in the battery. Shifting the bark will prevent any tendency of the swollen bark to pack so tightly that percolation is retarded.

The nine-vat battery is arranged to suit those tanners who want to shift the bark once during the time it remains in the battery. The centre vat receives all the dry bark which remains there for one day. The bark then is shifted into one of the outer vats, and the process now becomes the same as used for the eight-vat battery. All the strong head liquors are run off the centre vat. Each of the eight outer vats is connected with an overflow pipe, which leads into the centre vat. This centre vat is always at the head of the battery. All the plugs for drains to the well are placed in the overflow pipe.

Results seem to show that the higher temperatures (80° to 100° C.) are necessary before one can extract a good percentage of the total tannin from wattle bark. Davis writes that the best results for leaching are obtained when

the final liquors are at a temperature of 205° to 212° F. (96° to 100° C.). Parker and Proctor show that if the tannin from wattle bark be extracted at various temperatures, the best results will be obtained at a temperature of 80° C. They worked on an analytical scale, using finely-ground bark and an excess of water. The results obtained when all the tannins extracted were exposed to a temperature of 80° C. were the highest, and were called the maximum yield. So that their maximum yield and the total tannin in the bark, as found by the present analytical method for extracting tannin from bark, may differ, and probably the latter would be higher. When the results obtained by these workers at various temperatures were compared with results obtained, we notice that more tannin is extracted by Parker and Proctor, especially at the lower temperatures. This can be explained by assuming that the amount of tannin extracted at any constant temperature will decrease as the volume of water used decreases, and as the size of the particles of bark increases. The spent bark from the tail-end vats at 40° C. would probably still give off an appreciable amount of tannin if more water were used or more water and extra vats. The extra water would mean weaker liquors, and if the extraction were to reach the 94 per cent. obtained at this temperature by the workers mentioned above, it would probably mean accumulation of a great volume of weak liquor. To prevent this undesirable result and still obtain a greater yield of tannin in solution, one could raise the temperature of the tail-end vats to 95° C., as shown for the fourth experiment, when the yield was 90 per cent. of the total tannin.

The strength of the last liquor off the spent bark will always show if extraction is nearly complete for any one temperature. It may be said that if the final liquor from the spent bark of any process has a high density value, say above 3° barkometer, then the bark requires more water, or more cold or hot liquor as obtained by increasing the number of hot or cold vats in the battery. The amount of red tannins in a liquor is greater the higher the temperature of the liquors during the process of extraction and the greater the percentage of tannin extracted from the bark. All wattle barks contain a certain proportion of red tannins, which are only extracted at the higher temperature. The light-coloured tannins change to red when exposed to temperatures above 40° C., so that one could say that wattle-bark liquors always contain some red tannins that were present naturally in the bark, and other red tannins that owe their origin to high temperatures or faulty methods during the process of extraction.

If the light-coloured tannins be removed at a low temperature the more difficulty soluble or red tannins are left in the bark. Some tanners object to using the latter because of the reddish colour of the resulting leather. The amounts of tannin extracted at the various temperatures shown in these experiments are results that should show the tanner the value of temperature extraction process. The amount of tannin extracted and the colour of the leather is regulated by the temperature of the tail-end vats, and if a tanner reduced the temperature to improve the colour of the leather, then he also reduces the percentage of tannin extracted from the bark.

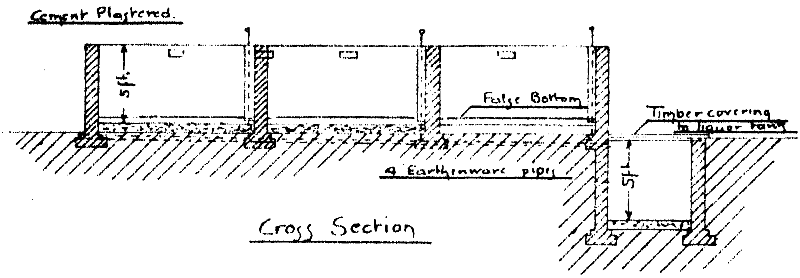
When 90 per cent. of the tannin is extracted with tail-end vats at 95° C. the resulting liquors are cloudy and red. These liquors are suitable for the average sole and harness leather. For special lines, where colour is an important factor, it may be advantageous to lower the temperature of the tail-end vats and reduce the amount of red tannin extracted from the bark, but before doing this for any leather, a tanner should consider what can be done to improve the colour by using a mixed tannage. Good results can be obtained on a slightly reddish leather by the careful use of small quantities of titanium salts.

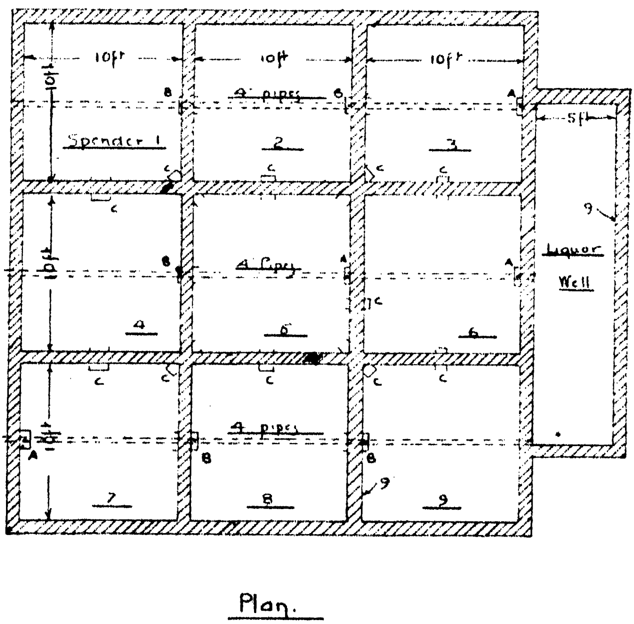
For the production of strap, bag, kip leathers, &c., it might be necessary to reduce the temperature of the tail-end vats to a considerable extent, but not lower than 60° C. The maximum temperature for extraction at a basil tannery would probably be below 60° C. A large number of tanners, who produce various leathers, only use water at ordinary temperature for the production of their liquors. Ordinary temperature in the cold season may be 12° C. (54° F.). Such a temperature is too low to give fair results. So that one could say that there is no tanner in Australasia who does not require to work some of his extraction vats above ordinary temperature.

These experiments have shown that very strong or highly concentrated liquors can be removed daily from the battery when the volume of liquor drawn off

each day is equal to the volume required to cover the wet bark in one vat, and if these results can be duplicated in the tanneries, the liquors would be stronger than any liquor required for the tanning of hides that pass through the splitting machine, or, indeed, for any skins.

If a tanner were getting a 60° barkometer liquor off the battery and only using a 40° barkometer liquor for his strongest one in the tan-yard, then he





A. Plug. B. Plug and Overflow. C. Overflow Pipe. Scale, ⅛" = 1 ft.

could reduce the strength of the liquor from the battery by taking off a greater volume of liquor per day, which would mean a similar increase in the volume of water placed in the battery per day. Now, any extraction process will be more efficient the greater the volume of water used per day when the daily quota of bark remains constant, so that it is not a good policy to take off liquors that are stronger than the best one required for any particular tannery. This applies to tanneries where the weaker liquors from the tan-yard are never pumped back on the bark.

Certain tanners pump liquors from the tan-yard back on to the bark. If the used colouring liquors are too strong to be pumped away, and must go back to the battery, then they should go into the vat which contains liquor about equal to their own density. This practice of pumping these liquors back on to the bark is a bad one, and contributes in no small degree to the bad odour noticeable at times with some leathers. It makes the extraction process more difficult by bringing foul matter into the battery, its economic value has yet to be proved even when tanners are colouring in strong liquors, and if the bark is properly spent by using the required amount of water the liquor drawn off each day must increase in volume and decrease as regards its tannin concentration. So that pumping back weak liquors may mean that the tanner will only get a weak liquor off the head of the battery. The weak liquor cannot replace water and give good results.

For these experiments the working operations are all completed within that period, 7.30 a.m. to 5 p.m., which might be called the working hours per day. This requires no further explanation than the statement that a process which required attention night and day would not be acceptable to 90 per cent. of the Australian tanners. A weak factor in these experimental processes is shown when the temperature of the liquors is allowed to fall during the night. The results obtained when the temperature of the tail-end vats is at 95° C. show that this procedure cannot be responsible for any great loss of wattle tannins. This to a certain extent is confirmed by the last two experiments, where the one at a maximum temperature of 40° C. during the working day, and the other at 35° during the working day and night, give approximately the same results. The difference of temperature would mean about 1 per cent. of tannin to be added to the latter.

The decrease in temperature during the night would certainly mean a greater quantity of coal used per ton of bark when compared with a process working on a large scale as described below.

The extraction of tannin from bark must be carried out on a large scale to get the best results. The greater number of Australian tanners do not use sufficient bark per week to reach this desirable standard, but the difficulty might be overcome by erecting an extraction plant capable of treating all the bark required by the tanners in any district.

This extraction process would be working night and day, and it would then be on a basis suitable for the manufacture of extract. The temperature of the vats at the head of the battery should not be higher than 40° C., as above this temperature the tannins change to a deeper red colour. With the front vats at 40° C. and the others at higher temperatures, two to three vats could be emptied and refilled per day, and the time for the bark in a six-vat battery would be two to three days. The tail-end vats could be kept at any suitable temperatures from 80° to 95° C.

The temperature of the first three vats at the head of the battery should not go beyond 40° C., because it would take quite three vats to remove the greater proportion of the light-coloured tannins. The temperature of the fourth vat would vary according to the temperature of the liquor pressed forward from the fifth vat, which would be about 80° C. in the overflow pipe, and it would decrease as it passed through the bark. The fifth, sixth, and seventh vats would be at a temperature of 80° to 95° C., and if extraction were complete with seven vats the eighth could be used to heat and remove impurities from the water.

The bark will never be completely exhausted as regards tannin, and if water has to be used in the extraction processes containing impurities, such as iron, salts, &c., which adversely affect the tannin, it will be desirable to first pass such water through these spent barks, when one could expect a considerable amount of the impurities to be removed.

SUMMARY.

1. Spent wattle barks, taken from various tanneries in New South Wales. contain considerable amounts of tannin, and these undesirable results can be attributed to the faulty methods adopted for the extraction of tannins.

2. Satisfactory results are not always obtained by tanners who grind their own bark. A mill is not doing good work when it allows any large particles of bark to pass through without being crushed.

The ground Adelaide bark used for the experiments described in this paper may be cited as a good example of how bark should be prepared for the extraction vats.

3. The additional cost of grinding, the mechanical agitators required, and the resulting cloudy liquors, are factors which adversely affect the use of bark in the powdered state.

4. For all practical purposes the maximum for a "one liquor period" when water is added to the wattle-bark is not above twenty-four hours, and this period decreases as the temperature increases.

5. An open diffusion and continuous process, worked on the press leach system, appears to be the most useful for the extraction of tannin from wattle bark.

6. Eight vats are recommended for a press leach system battery working under normal conditions; but when the bark swells to such an extent that percolation is retarded, then nine vats are recommended. By this means the tanner can shift the bark once during the process of extraction.

7. The amount of tannin destroyed, or the difference between the total tannin and the sum of the tannins in solution and in the spent bark, is apparently low for wattle bark. (Compare experimental results by Yocum and Faust.)

8. If the percentage of tannin extracted from a bark were a constant quantity, then the tannin concentration of the liquor drawn off each day would be inversely proportional to its volume, but one would expect that the percentage of tannin extracted from a bark would decrease as the volume of liquor drawn off each day decreased. Within the limits of the experimental work described here, it is considered that the minimum volume of liquor to be drawn off each day should be approximately equal to the amount of weak liquor that could be drawn off the bark in one pit.

9. The maximum volume of liquor that can be drawn off the bark each day will depend on the strength, or tannin concentration, of the strongest liquor required in the tannery.

10. High temperatures (80° C. to 100° C., or 176° F. to 212° F.) are necessary before it is possible to extract a high percentage of tannin from wattle bark.

11. Many tanners fail to get good results because they do not pass sufficient water at a high temperature through the bark.

12. Under the conditions described for these experiments, at least three vats must be raised to the high temperatures before sufficient hot liquor will pass through the bark to remove a good percentage of the tannin.

13. As the volume of liquor drawn off each day increases, the number of vats to be maintained at a high temperature decreases.

14. From an economic stand-point, the best extraction results will be obtained when the process is worked on a large scale, and one good extraction plant in the various Australian tanning centres could be expected to supply tannin in solution at a much cheaper rate than when each tanner treats his own bark.

In submitting the above results, the Committee feel justified in recommending the extraction process of the press leach system for wattle bark to the favorable consideration of those interested in the tanning industry, as it is considered that this process would be found more advantageous and efficacious than the methods generally employed in Australian tanneries.

The experiments of the Committee, as described above, were carried out almost wholly by Mr. W. McGlynn, chemist to the Committee at the Sydney Technical College Tanning School, under the continual and direct supervision of Mr. F. A. Coombs. While the Committee has had a large number of meetings during the currency of the work, the Committee considers it only right to draw attention to the fact that the chief burden of the work has fallen on Mr. Coombs and Mr. McGlynn.

The Australian Chemical Institute.

By BERTRAM J. SMART, B.Sc. (Lond.).*

With a few notable exceptions, there can be little doubt that, until the last few years, the profession of chemistry in Australia occupied a position of minor importance in comparison with other professions, and, as a consequence, showed very little sign of progress. It is true that each State possessed a Government Analyst, whilst certain large undertakings, as, for instance, the Colonial Sugar Refining Company and various mining establishments, carried a well-organized scientific staff. Moreover, in the various capitals many consulting chemists practised their profession with more or less success, depending to a large extent on the mining industry for their regular work. On the other hand, it is probable that the mind of the ordinary public scarcely appreciated the services which the chemist rendered the community, and had no conception of the important part which chemical knowledge should play under the stress of modern life. But the war has changed all that. Out of the turmoil has come another revival of learning, which has swept the world and has taught the man in the street that in every stage of life he is dependent on chemical science, and that not only life in all its phases, but the production of food, clothing, and other means to existence are one huge chemical reaction.

One of the results which this scientific renaissance has brought about is a desire on the part of the chemist himself for organization, which has made itself manifest in all parts of the British Empire. In Australia, that desire has now taken practical shape in the formation of the "Australian Chemical Institute," which has grown in three years to a membership of well nigh 600, and promises to develop into an important instrument in the national progress. It will be of some interest to put on record how this Institute was formed, and to set out some of the objects which it hopes to achieve.

Before doing so, however, it is necessary to mention that, for the last 40 years, a well-known body, the "Institute of Chemistry of Great Britain and Ireland," has been in existence, and, incorporated under a Royal charter, has comprised within its ranks a large number of chemists, both in England and abroad. Early in 1916, a movement was on foot to form branches of the Institute of Chemistry in the Dominions, and the Fellows resident in Australia, numbering between 50 and 60, had already taken preliminary steps with this object in view. Since it was formed, the Institute of Chemistry has steadily raised the standard of admission to its ranks, and the right to use the now well-known letters "A.I.C." or "F.I.C." is clearly recognised as evidence of a thorough training in practical chemistry. Until quite recently, in order to gain admission to the associateship, a candidate was required to undergo a course of training at an approved institution, and also to pass an examination of a high order, whilst the Fellowship was granted to Associates who had practised for three years, and had undergone a further test. For reasons which need not be discussed here, however,

* Hon. General Secretary of the Australian Chemical Institute.

a considerable number of highly trained men in England declined to associate themselves with the Institute. Moreover, the Institute could scarcely be regarded as a body which embraced the large number of men employed as works chemists. For the career of public analyst, however, the qualifications granted by the Institute were generally regarded as essential.

It is necessary to touch on these matters, since they entered largely into the discussions which took place before the Australian Chemical Institute was formed, and it must be admitted that, to a certain extent, its founders were guided by a desire to avoid, if possible, any of the results which had been found unsatisfactory in Great Britain. The scheme to create an Australian Branch of the British Institute never matured; it was swept aside when discussions began to take place on the creation of a new body formed and controlled in this country. Even had such a branch been formed, it is doubtful if it would ever have been able to control the chemical profession in Australia as a whole, since the powers delegated to it by the parent body were too limited in character, and would undoubtedly have proved a serious handicap.

Whilst this proposal was under discussion, a few works chemists got together and formed themselves into a body named "The Australasian Chemical Association." This association was moulded on the lines of a trade union, and persons in a position of control were expressly prohibited from joining. No qualifications for membership were required, and the objects were principally the protection of the interests of persons employed on chemical work. One of the indirect results of its formation was to set a large number of men in Melbourne talking and thinking out a scheme, which ultimately took practical shape. The notion of a chemical trade union was put aside as unsuitable, and from the discussion which took place one prevailing idea grew up—the creation of a professional institute which should guarantee to the public the ability of its members and demand that skilled services should be adequately rewarded.

Thoroughly imbued with the prevailing spirit, Professor Masson, whose lively interest and never-ending resource may well entitle him to be called the "Father of the Institute," came over to Sydney and addressed a meeting of chemists on the 26th July, 1916. A keen discussion took place, and the meeting finally formed itself into a committee to promote the formation of a "chemical association." The writer was appointed provisional secretary and convener, and at a subsequent meeting an executive committee was appointed. The Sydney executive at once commenced active work, and similar committees were formed in Melbourne and Brisbane without delay, followed at a later date by committees in Adelaide and Perth. Discussions took place between these committees by correspondence during the next six months, after which a conference was held in Sydney on the 10th January, 1917, which was attended by Dr. Cooksey (N.S.W.), Professor Masson (Vic.), Professor Rennie (S.A.), and Mr. J. B. Henderson (Qld.). In the previous discussions, some considerable difficulty had arisen over the name to be adopted, but the conference soon arrived at a decision, and, in addition, drew up a draft constitution. One of the great difficulties which had to be surmounted was the choice of a suitable scheme for the formation of a central executive. It was largely owing to the

express wish of Melbourne chemists that Sydney was unanimously agreed to as the head-quarters of the Institute. In a country such as this, in which the principal cities are so far apart, it is not easy to elect a representative council which can conveniently meet and transact business. Eventually it was decided that the council should consist of the Presidents of the State Branches, who may nominate some person to act for them, whilst it was agreed that meetings might, if necessary, be held in any of the State capitals. Since this scheme was ultimately adopted, it has meant that a number of Sydney chemists govern the Institute in the name of the State Presidents. On the whole, the system works fairly well, in spite of the unavoidable troubles which are inseparable from such an undertaking.

The draft constitution was circulated again amongst the State Committees, and, after further amendments had been made, it was printed and circulated in June, 1917. Applications for membership were then dealt with by the Provisional Committee in each State, and from the persons thus elected as members the State Branches were duly created. In most cases, a formal annual general meeting was held in September, 1917, and officers appointed. The following were elected as the first State Presidents:—New South Wales, Dr. Cooksey; Victoria, Professor Masson; Queensland, Mr. J. B. Henderson; South Australia, Professor Rennie; Western Australia, Professor Simpson. These gentlemen became the Council *ex officio*, and the first meeting of the Council was held on 8th-9th January, 1918, Dr. Cooksey and Professor Masson being present, whilst Mr. Boas represented Professor Simpson, Mr. Radcliffe represented Professor Rennie, and Mr. Mingaye represented Mr. Henderson. Dr. H. G. Chapman was elected honorary general treasurer, and Mr. B. J. Smart was elected honorary general secretary. The Institute was thus duly formed as the "Australian Chemical Institute."

As already pointed out, one of the important functions which the Institute was intended to fulfil was that of guaranteeing to the public the qualifications of its members. It was therefore necessary from the outset to scrutinize closely the qualifications of those applying for membership, and to see that none were admitted who were not thoroughly competent. At the same time, in order to insure that all persons *bonâ fide* qualified as chemists should be able to gain admission, the door had to be left open sufficiently wide.

In fixing the standard it was decided, in the first place, that membership should be open, firstly, to a graduate in science of an approved university, provided that chemistry formed one of the degree subjects; secondly, to a person who had obtained a diploma in chemistry at an approved technical college; and, thirdly, to a Fellow or Associate of the Institute of Chemistry of Great Britain and Ireland. Under the second heading, it was understood that only those diplomas would be approved which involved a systematic training in the science. In addition to the above, membership was made open for a limited period to teachers of chemistry, heads of commercial laboratories, or assistants recommended by them, provided in each case the applicant had been employed on chemical work for at least three years. This provision remained in force until the 1st January, 1919, except in the case of persons away on war service, who may still avail themselves of it. It is now necessary that any person who does not qualify under the first

three headings, unless he have some special qualifications for admission, shall submit himself for examination in such a manner as the Council may decide. At the present time, the regulations for examination of candidates are being considered, and it is hoped that they will shortly be available for issue. Although not yet finalized, it may be stated that, in addition to a professional examination, an entrance examination will be required. Special arrangements will be made to deal with candidates who have passed through technical colleges in which the standard of education is not equal to that demanded above, but this arrangement will probably be only for a limited period, and on the understanding that such colleges take steps to bring the standard into line at an early date.

In addition to the above provisions, the Council is arranging for a student grade, and also for a fellowship. Persons who have received a good general education, and who are undergoing a systematic training for the profession of chemistry, will be eligible for admission as students. The fellowship will only be granted to members who have attained a high degree of proficiency. It is intended to maintain a very high standard in granting this qualification, so that it may, from the outset, be regarded as the blue riband of the chemical profession.

An important question, which is at the present time occupying the minds of many of the members of the Institute, is that of incorporation. This problem presents a number of special difficulties owing to the anomalous character of the Australian Constitution. Whilst it would be quite a simple matter to form an Institute in each of the separate States, the Commonwealth Government appears to have no power to grant to a body such as this, spread over the respective States, an Act of Incorporation. In order to obtain sound information on this point, the Council of the Institute submitted the question to Professor Harrison Moore, who is a very high authority on constitutional law, and, from the advice thus received, it is apparent that there is no hope at present of the Institute becoming incorporated by a Federal Act. The position, therefore, leaves only three courses open. On the one hand, the Institute may take action on simple lines by registering in each State under the Companies Act; or, on the other hand, a Bill might be promoted in one or other of the States with the object of obtaining an Act of Parliament. It would then be necessary to get the remaining States to pass an Act in similar terms. The third alternative is to approach the Crown direct, and seek a Royal charter, such as was granted to the British Institute of Chemistry. It is rather interesting to note that the latter body did not become incorporated for a period of seven years after its formation. Looking through the accounts which appeared at that time in the *Chemical News*, it is noticed that at one period of its existence it was intended to register under the British Companies Act.

Up to the present the Council have not come to a definite decision on this matter. It is recognised, however, that, if it is decided to petition the Crown for a charter, it will be necessary to obtain the support of the home Institute of Chemistry. With this object in view, a letter has already been sent to the Secretary in London setting forth the position in which the Institute finds itself, and asking if the Council would kindly inform the "Australian Chemical Institute" what attitude it would be likely to adopt should such a petition be put

forward. It is hoped that a reply may be received by cable in time to be presented to a conference which will take place in Sydney during the middle of February.

Intimately connected with this matter is a proposal, which has been put forward in Victoria, that chemists should seek from each State Government power to close the profession. A Professional Chemists Bill has been drafted with the object of creating a Board similar to that now in existence in connexion with the dental and pharmaceutical professions, who shall be empowered to insist upon a certain standard of training for every person who practises chemistry. This Bill has been put forward with much enthusiasm by the Victorian members, who believe that the present time is favorable to the passage of such a measure into law. Under the constitution of the Institute a State has power to deal with any local matter which does not affect the other States. Such a measure as this, although apparently local in its incidence, is intimately connected with the proposals for incorporation. If it is intended to incorporate on State lines, it would be highly desirable that the two matters should be put forward together, or the question of incorporation should first be dealt with. At the request of the Council, the Victorian Committee has withheld further action pending the Council's decision regarding the question as a whole.

Amongst other work which the Institute has already accomplished, mention may be made of the attention which has been given to the desirability of standardizing professional fees, to the adoption of uniform methods of analysis, and to the formation of an employment bureau, which will bring chemists more directly into touch with manufacturers and others offering employment.

Inquiries were first made from each State Committee as to the fees now charged by professional chemists, and suggestions were called for regarding any items which should be increased. When this information was collected, the Council appointed a committee to consider the schedules, and to draw up a standard of minimum fees for the whole of Australia. This was carried out, and again submitted to the State Committees, after which further alterations were suggested. When these have been reconsidered a schedule will be circulated amongst the members of the Institute, comprising minimum fees which it is recommended should be charged for analytical and consulting work. It is obvious that in a matter of this kind the Institute can only rely on the loyalty of its members in adhering to the recommendations put forward, but there is little doubt that the consulting analysts of Australia, as a whole, will adhere closely to this schedule when it is finally issued.

The work of standardizing analytical methods had already been commenced by the Victorian Society of Chemical Industry, acting in conjunction with the Institute of Science and Industry. It was thought, however, that this duty should be carried out by the Australian Chemical Institute owing to its wider representative character, and the investigations were, therefore, transferred to a committee appointed by the Council, consisting of representatives in each State. It is to be expected that a work of this magnitude will continue over several years. A number of chemists have already worked on the methods for estimating phosphoric acid in fertilizers, but no report has yet been submitted. With the machinery

in existence, however, it is hoped that, as time goes on, a systematic investigation of all the principal analytical methods adopted in commercial analysis will be undertaken. This will enable the public to depend with certainty on any analysis carried out by a qualified analyst following the methods laid down by the Institute, and will prevent much of the unfortunate lack of agreement which has frequently been encountered in the past.

The work of the Institute could hardly be regarded as complete until some efforts had been made to bring its members more closely into touch with the conditions of employment as they exist in the several States. It is somewhat difficult to create a system under which information regarding all vacancies shall be furnished to the Secretary of the Institute. Such an objective naturally takes time to accomplish. Steps have, however, been taken in this direction, and a circular has been issued to all the principal manufacturers asking that, should at any time they require the services of trained chemists, they should communicate with the Honorary General Secretary of the Institute. Up to the present, there has been very little result from this course of action, and only a few of the members of the Institute have so far approached the Secretary with a view of seeking employment.

When this side of the Institute's activities grows, as it is expected it will do, there will undoubtedly be a considerable volume of work to be transacted, and it will be necessary to extend the staff of the headquarters accordingly to deal with the same. It should, however, be possible by proper machinery to place any chemists out of employment in immediate touch with firms and others who are looking for suitable men, and the successful creation of such a bureau will, in the near future, be one of the Council's first duties.

Enough has been said to show that in the short space of two years an important factor has come into existence for the good of the chemical profession. Looking back once more to the history of the Institute of Chemistry in England, we find that it took several years to bring about what has already been accomplished in Australia. In the case of the British Institute, seven years elapsed between the date of formation and the date at which a charter was granted. Much opposition was encountered, and many suggestions were put forward as to the form the Institute should take. In the early days, many men were admitted to its membership who would now be unable to gain admission, the standard having been so considerably raised in the meantime.

The Australian Chemical Institute will undoubtedly encounter similar experiences as time goes on. The number of partially trained men coming forward will be diminished, and the Institute will take particular care to see that persons desirous of becoming professional chemists shall receive a proper training for the work they intend to carry out. It cannot be expected that a profession which includes many men whose training is only partial can at present hope to obtain the emoluments which certain other professions enjoy, but with the improvement which the Institute will undoubtedly bring about this must alter.

The Council to-day is legislating for posterity, when all those who practise the profession of chemistry may, in return for efficiency and valuable services, receive a full share of the rewards which these services produce.

Notes on the Rhineland Chemical Works.*

By J. ALLAN.

PART II.—LABOUR CONDITIONS AND RECENT PLANT EXTENSIONS.

It has frequently been said that cheap and docile labour has been a great factor in the success of German industry generally, and that it has contributed not a little to the advancement of their chemical manufacture. A statement of past and present conditions, therefore, may not be without interest, but it should be emphasized that any existing conditions are probably transitory, and that it is impossible to forecast the state of labour in the future, either in Germany or elsewhere. In pre-war times long working hours were general throughout Germany, though there was a growing tendency to curtail them, and the "good firms," so named, which did not necessarily mean the large firms, were adopting "English" time as it was called, which meant working to 12, 1, or 2 o'clock on Saturday instead of the 5 or 6 o'clock, which was formerly the rule. Wages in the chemical industry were peculiarly variable, there being apparently no fixed rate in different factories, and in certain districts of a rural character, where it might be thought low rates would rule, they were higher than in more populous areas, though many exceptions to this might be found even in contiguous works in the same neighbourhood. The case of one of the large works may be cited as a general example of the change which has taken place both as to the cost and character of the labour supply. Under pre-war conditions a 66-hour week was common, and the rate of pay for general labour was 0.65 marks per hour, or a weekly wage of 43 marks. Since then the eight-hour day has been forced upon employers, and for similar labour the hourly rate has risen to 1.7 marks, which means a weekly wage of 81.6 marks—a 90 per cent. increase in the total wages earned, with a reduction in working hours of almost 28 per cent. If it be assumed that the output of work per man per hour has not changed, and chemical processes as a rule cannot be accelerated, it follows that the labour cost for the same output of work as formerly has risen to 112 marks—an increase of no less than 160 per cent. It is quite commonly asserted, however, and it is plainly evident, even to a casual observer who was familiar with pre-war conditions, that the character of the labour has considerably altered, both as to subservience to discipline and the quality of the work done. Lack of attention to instructions and carelessness are common, and the general assertion is that the possible output is now only about one-half of what it was. It is probable that this statement includes the reduction following upon the lessened number of hours worked, as well as that arising from lowered efficiency, as figures derived from industry, such as certain branches of engineering, where output can be carefully determined by the number of articles produced, show a minimum reduction in output per hour of about 25 per cent. How much of this arises from the fact that for reasons of policy generally they are employing, or, more

* Journal of the Society of Chemical Industry.

correctly, are paying their pre-war labour force, whilst their actual output is in some cases as low as 10 per cent. of the possible, cannot be determined; it may be assumed that, with fuller employment present conditions will be modified, but one cannot help feeling that the old conditions will not return, and that the difficulties surrounding present-day labour problems are not to be confined to Britain alone.

In speaking of output, however, some notice must be taken of the present condition of the German factories, and especially of the changes which have taken place in them during the long period of war. All of the factories having facilities for the manufacture of materials for explosives or gas warfare have greatly increased their plants during this time. It is quite evident, also, that these additions have been made in no haphazard fashion, but that full consideration has been given to the possibility of using these essentially war additions to the buildings and plant for industrial purposes when the war demand had ceased.

In general, and in the case of the large plants certainly so, it has been left to the factory control to provide for the increased output by such means as they chose to adopt, the Government affording every facility in the matter of materials and labour, and, it is stated, also providing the money required for the erection of the plant. The system of financing these extensions has apparently been that of repaying from time to time the expenditure incurred, and cases are not wanting in which large new plants have been erected on Government behalf at a late period in the war, in which these repayments have not taken place, and firms are now in possession of very expensively erected buildings and equipment which they would not have built in normal circumstances.

There is a generally expressed fear that the abnormal cost arising from the circumstances in which these extensions were carried out will not be met by the new Government, and that the factories will have to bear the major portion, if not the whole, of the charges thus incurred. This, of course, only applies to work carried out during a late period of the war, and many enlargements of plant have taken place which the erectors have obtained on such terms that capital charges upon their peace output will not be excessive. Probably no better example of the permanent character of these hurried extensions is to be found than the Dormagen plant for the production of picric acid and TNT, belonging to the Bayer company, which is situated on the left bank of the Rhine and a little way removed from Leverkusen, which is on the opposite side of the river. The buildings, which were begun late in 1916, are all solidly constructed of brick and ferro-concrete, the sulphonating and nitrating houses following in detail the general plan which has been adopted as the standard for such work in the Bayer plants. Two units for the manufacture of picric acid were completed, each having a capacity of about 900 tons per month, and the first of these units was in operation within six months of the commencement of erection.

The nature of the buildings and the substantial and finished character of the plant leave no doubt whatsoever that they are intended to be a permanent addition to the Bayer factories, and with very little alteration they can be converted into a large installation for the manufacture

of intermediates and dyes. The plants of the dye-producing firms are in excellent condition, and in many cases have been considerably added to in producing power during the period of the war. If competition with German dyes and pharmaceutical chemicals was difficult in pre-war periods, it certainly will be no less so in the era which is opening before us, if efficient plants and large scale production are the important factors in production costs which we all know them to be.

The term "a chemists' war" has been applied over and over again to the great struggle which we have just passed through, and in no sense is the application of the term more true than when it is applied to the fact that, without the plants erected in her chemical works for the fixation of atmospheric nitrogen, the resistance of Germany would have broken down at a comparatively early date. As an instrument of peace or a weapon of war, such plants are almost invaluable, and the peculiar independence of Germany from the supply of Chilean nitrate is one of her greatest national assets. It is said that the German Government, at the instigation of her military experts, adopted the position of foster mother to the various processes which were being developed in the country in pre-war times.

Their maternal instinct was roused only by the effect which the supplies from these plants would have upon their military needs, and it would appear to be something more than coincidence that the first steps towards initiating a great European conflict were not taken until the Haber process, with its immense possibilities, had been fully established on a large scale by the Badische Company, and that plants were also in existence for the production of ammonia from cyanamide. Important as nitrates are as a provision for war, their value as affecting the foodstuffs of a nation needs no argument, and it may yet be the case that the now generally decried militarism of Germany has given to the country a boon whose worth is inestimable.

The plants at Oppau and Merseburg, in which the direct synthesis of ammonia from hydrogen and atmospheric nitrogen is effected, are enormous in their dimensions, and a monument to the skill of the chemists and engineers who have erected them. Similar words may be applied to the plants at Höchst and Leverkusen, in which ammonia is oxidized to nitric acid; and the imposing sight of the interior of the building at Höchst, which houses 256 platinum catalyst vessels with their various connexions, is one which a chemist cannot easily forget. The capacity of this particular plant is 8,000 tons of HNO_3 of 100 per cent. strength per month, so that approximately 1 ton of HNO_3 is produced by each catalyst vessel per day. The whole installation, with its plant for vaporizing ammonia, fans, catalyst vessels, absorbing towers, and nitric and sulphuric acid concentrating plants, is an outstanding example of the mass-production policy which has been so largely adopted by the German chemical firms as a means towards reducing production costs.

A striking feature of this and very many plants for other purposes is that, though in the aggregate the output is very great, the plants themselves consist of many units, each of which is a complete plant in itself, and enlargement of output is arrived at by erecting a fresh series of units, rather than by increasing the size of the constituent parts of the unit.

The benefits which arise from this system are many, since it is possible to erect a plant of large capacity from a minimum of drawings and patterns, and the ordering and construction of parts become simple. Also, it allows of the use of appliances of standard dimensions, which are generally kept in stock by ironfounders, earthenware manufacturers, and the like, so that time is saved in erection as well as in cost, since the parts which call for special construction are reduced to a minimum in number. It might be mentioned that the plant just spoken of, which was completed and put into operation in February, 1918, cost £2,000,000, and was erected in six months.

Another matter which is forced upon one's notice in these large works is the fact that, though the variety of their products is great, there is no reckless plunging into the manufacture of an article which is not connected in some way or another with what is the essential part of their business. As an example of this, we may consider a few of the operations of the Bayer Company, at Leverkusen. It would appear at first sight that the manufacture of superphosphate of lime was clearly dissociated from the essential business of the factory, *e.g.*, the manufacture of dyes and pharmaceuticals. Nevertheless, a superphosphate plant, having a capacity of 50,000 tons per annum, was built and brought into operation shortly before war opened. The reason for this departure was the fact that a large quantity of weak and contaminated sulphuric acid is produced in many of the plant operations, which could be made re-usable for such purposes only after being purified and reconcentrated, processes which are costly in time and labour and wasteful of material, since much organic matter has to be oxidized at the expense of the sulphuric acid it is desired to recover. To use new acid for the prime factory processes and waste acid for the purpose of rendering phosphate rock soluble is, therefore, a perfectly connected development of their business.

Another example: It would appear that the manufacture of 800 tons per month of the mixture of zinc sulphide and barium sulphate, known in the paint trade as "lithopone," was outside the field of the manufacture of organic chemicals, but the extensive use of zinc dust for reduction purposes provides the key to this seeming departure from connected extension of the manufactures, since the solution of zinc sulphate obtained from these reductions is the starting material for the preparations of lithopone. An endeavour to recover the sulphur in precipitated calcium sulphate, which accumulates in large amount in such a factory, is a clear extension of their business, and, besides, is fraught with immense possibilities, since success in doing so would place an enormous amount of material at hand for the manufacture of sulphuric acid in the shape of the large natural deposits of gypsum. This process is actually being worked on a large scale, but complete success is not yet attained, although several thousands of tons of calcium sulphate have actually been passed through the plant.

As already indicated, a valuable aid to the development of manufacturing processes in the Rhineland area is the great beds of brown coal which lie a little way removed from the river, between Cologne and Crefeld. The ease of working these beds permits of power being obtained at very low cost, and there are several large power stations situated right on the beds which have distributed power to consumers

at about ⅛d. per unit in pre-war times, and to-day the cost is stated to be only two-fifths of a penny.

The Stickstoffdunger Fabrik, which manufactures carbide and cyanamide at Knapsack, in the brown-coal area, formerly produced power at slightly less than one-tenth of a penny per unit in its own power station, but recent increased labour and material charges have raised this cost to the still very low figure of less than three-tenths of a penny per unit. It is not to be wondered at that the development of electrical furnace work and electrolytic processes has been great, and it is difficult to see how competition with these is to be met unless the projected central power schemes proposed for this country can distribute power at equally low rates.

I have already commented upon the great amalgamation of interests which enabled both internal and external competition to be stifled so effectively. This *rapprochement* has had the effect of bringing firms of very diverse interests into extremely close working touch with each other, and it may not be without interest to quote some examples of this in German works. As is well known, a process for the synthetic manufacture of acetone was worked out in this country which involved three catalytic operations, viz., the production of acetaldehyde from alcohol, the oxidation of this aldehyde to acetic acid, and the subsequent conversion of the acetic acid into acetone. In the similar process worked in Canada, the first stage was the preparation of acetaldehyde from acetylene.

A pressing demand in Germany for acetic acid led to the establishment of a similar process at the Farbwerke Höchst, the acetylene being prepared from calcium carbide supplied by the Stickstoffdunger Fabrik at Knapsack. It was apparently early appreciated that it would be highly economical to carry out this process in close proximity to the Knapsack works, since the carbide could then be obtained on the spot, and, further, the oxygen required for the oxidation could be obtained from the Linde apparatus, which supplied atmospheric nitrogen to the cyanamide plant in the Stickstoffdunger factory, this oxygen having been practically all returned to the air. This realization was so far acted upon that a plant belonging to, and entirely operated by, the Farbwerke Höchst staff was erected within the Stickstoffdunger works, and the separate property of this plant was so far maintained that even the most highly placed officials of the Stickstoffdunger factory were not allowed access to it. Other cases of a somewhat different nature may be cited. The large ammonia oxidation plant at the Leverkusen works of the Bayer Company used an oxidizing catalyst supplied by the Badische Company, and, although the Farbwerke Höchst operates a large plant for the manufacture of hydrosulphites, the quantity of the latter which was used at Höchst in the manufacture of salvarsan came from the Badische factory, at Ludwigshafen, because, it was said, of its special purity.

Thus far we have considered, in the main, the great factories which are undoubted models of equipment and control, but there are many others on an entirely different scale, and, it must also be said, some as badly equipped as the most antiquated of any of our English factories, and this is particularly the case with some of the works engaged solely in making heavy chemicals.

Many others of these smaller works are as efficiently operated as the large ones, and on their own scale are as well provided with plant and scientific control. A peculiarity of German chemical manufacture is the large number of very small firms engaged in the preparation of a very few substances. Their output is invariably specialized in character the processes used, as a rule, yielding no by-products. Some of these businesses are so small as to be almost one-man concerns, the owner of the business being at once works manager and salesman, his factory being erected in what would have been the garden of his house; indeed, in some cases it is in the house itself.

It is probable that the large number of men who have received chemical training is responsible for so many of these small businesses being carried on, and, as their operations are outside the field of the large works, their existence is not endangered by competition with them. In some cases they are even useful to works on a greater scale, as they provide necessary articles, the consumption of which is so small that it is not worth while a large firm taking up their manufacture. A case in point is that of decolourizing carbon, a well-known brand of which, along with other similar products, is made in a factory of the size of a small private house.

From all that has been said, it will appear that competition with Germany in all branches of chemical manufacture is likely to be even more severe than it has been in the past, and, although I have carefully and designedly avoided the temptation to point morals, they are plainly contained in the facts I have placed before you.

I make no assertion that these facts are the sole causes of the growth and success of Germany in her particular branches of chemical industry, but they have certainly contributed most largely to it. I do not advocate a slavish copying of their methods, but profit lies in a knowledge and appreciation of them, and the application of the good that is in them, modified to suit our own needs, will surely be to the benefit of the industry.

Some Scientific Points Which Arise in Cabinet Making.*

By OCTAVIUS CHARLES BEALE, F.R. Hist. S.

IN preparing a short paper upon scientific points which arise in cabinet making, my object has been not at all to set forth advance in the art or to deal with the general principles which guide designers and artisans in a very ancient handicraft, but rather to point out here and there matters of interest which may concern those who are not engaged in its practice. As to advance there is unhappily none to record excepting in methods and devices to facilitate production, or to insure durability or reliability. Since the "art nouveau" first exercised its malevolent influence upon architecture and internal furnishing and decoration there has been a pitiful vanishing of a true taste in unison with those canons of comfort with elegance which were themselves the slow product of the ages.

On the other hand, both in Europe and America there has been always a minority who perceive and enjoy the beauty of utility combined with propriety of form. To these, including pre-eminently the producers, is due the preservation of what is called "period styles," meaning adaptations to furniture and fittings of designs taken from former centuries which had been proved and admitted to be within the aforesaid canons of comfort with elegance. At Grand Rapids in Michigan, on Fifth-avenue, New York, in the Curtain-road, or New Bond-street, London, in the Avenue de l'Opera, or Montmartre, of Paris, wherever the furniture is made or sold, the producers—employers and artisans—are glad to see art preserved, but are content to take their bread and butter from what they denominate with a smile the "primitive taste" that is prevalent. The brothers Adam probably derived their chief inspiration from the palace of Diocletian at Spalatro, whose internal ornaments possessed delicacy and grace in form rather than imposing size and shape. I happen to be a member of council of the Royal Society of Arts and Crafts, whose abode is in John-street, Adelphi, London, and in whose neighbourhood is preserved some of the Adams' work that is still not without its influence.

The deplorable "art nouveau" if it did not originate in Germany had at least its chief promulgation thence, so that with the defeat of Teutonic influence the world may hope for a return to grace in more ways than one.

It is a common belief that the system of veneering is merely a practice of deception, but it should hardly need demonstration that cheapness is scarcely attainable by sawing or slicing lumber into laminæ and attaching these by adhesives alternately in longitudinal and transverse plies. A board 1¼ inches thick when sawn into two ½-in. boards

* Read before the Industrial Section of the Royal Society of New South Wales.

that are glued together effectively end-for-end, becomes a more reliable piece of lumber than before. Still better when, for example, we take a ½-in. board and build it up to 1 in. by plies of the same or other suitable lumber on back and front. The plies ought always to be odd in number, three, five, seven, and so on, whilst they should be so chosen and applied that the inevitable strains set up by an organic material shall be duly reckoned with and balanced.

The high ornaments—apart from medullary rays—are always due to the presentation of end grain to the surface, whether it be due to sinuosities, to butt or crotch growths or to abnormalities in the trees. That being so, the wood must be brought down to thin sheets, and attached to plain, straight-grained boards, preferably of its own nature where practicable. Otherwise, if left solid, it must warp, crack, or buckle for lack of something to hold it securely to a level.

During many years I have examined the processes of laying ply-stock in the largest and most prominent manufacturing plants in the world, in America—where there is the most for the student, though not all, to learn—in France, England, and Germany. The chief problem is, having found suitable lumber in quantity, to cut, dry and lay the ply-stock with proper adhesive. Much knowledge and skill are demanded in the two first, but it is easier to cut, either with saw or knife, than to dry effectively without injuring the product. Many drying systems are employed, some of them curiously elaborate, but we have not time here to consider them.

I called upon a kindly man in New York years ago, whose company is, I believe, the largest producer of veneers in the world. They are not sellers of the product, but are manufacturers on an immense scale. "Look over that box," said he, "and tell me what you think of it while I finish this letter." Presently he asked my verdict, and, well knowing there must be something beyond what was visible, I said "I don't think anything of it. It is an ordinary box about 2 feet cube, with locked corners, a good but common-place system, is of three 8-in. plies, and nothing more to be seen." "Oh, indeed," said he, "you think nothing of it! Well, tell me what you think of this," handing me a very rough and damaged head of a barrel, apparently of similar construction. "That," I replied immediately, "is one of the most wonderful things I have ever seen." "Ah, you hold that to be wonderful and you think nothing of the box. What is there wonderful about it?" "You have had it torn to pieces," I replied, "and it is of a hard wood, yet it parts everywhere but at the joints. You did not succeed once in breaking the joints." It was an experiment in adhesives, not animal glue, not casein.

That man's organization was then making 40,000 barrels a day, truly a colossal total, only estimable, perhaps, by those who reflect what operations these figures involve. And there were other departments, chiefly three-ply containers of various forms. The operations of all in the cabinet-making trade who employ similar methods on a great or small scale, are puny in comparison. Even the Singer Company at South Bend, Indiana, the Grand Rapids furniture people in Michigan, the Pullman Car Company, or Messrs. Lebus at Tottenham.

The company mentioned own 160,000 acres of forest in one of the southern States, and regularly reafforest the land as they cut out the timber at the rate of about 4,000 acres annually, besides what they purchase in lumber. That reafforestation is in itself an interesting story, being in actually successful application by a mercantile concern, and their practice is by no means unique.

Veneer-cutting is accomplished in at least three different ways: by sawing, by rotary cutting or peeling, and by straight slicing. Where the quantities used are very great the peeling system is employed, that is to say, round logs after boiling are placed in lathes, and so, revolved against a vibrating knife, are thus sliced into endless sheets until the useless heartwood is reached. This core is commonly 6 or 7 inches in diameter, and properly becomes waste.

In straight slicing a squared log is made fast to a table that is elevated by mechanism automatically to the thickness of veneer required. A knife borne by a heavy carrier is driven with great force diagonally across the log, producing perfect sheets of veneer with rapidity, but at a less speed than the continuous rotary motion already described.

Both of these methods have the advantage that there is no loss, or waste by saw-kerf, but against that there is the unavoidable defect that the grain or fibre of the wood is disturbed. The imperfection may be so slight as to be unimportant, yet with some timbers, such as rosewood of all kinds, blackwood, or oak, it is so great as to mar good work, and the slicing method ought not to be employed.

For all timbers unquestionably the best result is obtainable, as to quality, by using the sawing method. In this the French are masters using a horizontal saw against a log which slowly ascends, thus cutting the finest boards without disturbing the fibres. In other countries a circular saw of about 8 feet diameter is used, which is less slow than the horizontal saw, but delivers a rougher board. With the French system it is possible to obtain sixteen perfect boards, ready for glueing, out of each inch of thickness. Nevertheless there is the unavoidable waste by the saw-kerf, which is more than countervailed by the fact that the fibres are quite undisturbed, permitting sound work as a result. The usual thickness of French veneers when knife cut is half a millimetre, or fifty to the inch, and in case of fine walnut burrs sixty to the inch. At Annandale a machine is used in our works with a knife 10 feet long, which slices logs up to 4 ft. 6 in. in width. The longest knives in use are 17 feet, requiring carriers of great weight and machines of massive construction.

Ornament is sometimes due to abnormal growths in the trees. This leads to a study which has not, I believe, received due attention. Some years ago I was able to assist the late Professor Charles Stewart, Conservator of the Hunterian Museum at the Royal College of Surgeons, by procuring for him certain specimens of animals that were difficult for him to obtain. I mentioned to him the remarkable aberrations or distortions of growth in some Australian plants, different from those in Europe and elsewhere, as being well worth some one's studying microscopically and histologically. This in the hope that the acquired knowledge might, in some way not to be foreseen, eventually help the pathologist. "Ah, no," he said, "we have a large collection of galls

and wens of plants, but the trees don't die of them." I could not and would not argue the point, but said I would examine such growths further upon returning to Australia. This I did in several States and in many forests, having handled almost acres of sections of burrs, stumps, and wens.

After the lamented death of Professor Stewart, whose lifelong and painstaking research, and whose elaborate preparations, were the more marvellous because of his imperfect eyesight, he was succeeded by Professor Arthur Keith. Again in London two years after I renewed the subject to that eminent man, who very much desired sections and specimens. But I hold that the examinations should be on the spot and during the life of the plant. It is too wide a subject to more than mention, but it should be said that the plants do and must die because of certain abnormal growths. I caused a remarkable wen of perfect solidity and about 8 feet in diameter to be removed from a so-called mahogany tree on the south coast of New South Wales. We remarked that the misdirected energy—so to speak—and the extreme complexity of the growth, added to the enormous strain and pressure upon the contained parts, must be all but a fatal tax upon the tree. The tree proved to be completely hollow and barely living, although the great wen was sound in all parts. Commercially, however, we did not use the wen when brought to Sydney.

It is a mistake to jump to conclusions as to these wens on different kinds of trees being due to insect attack. Many of them are perfectly free from perforations or faults of any kind even when of extraordinary size, and it is usual that a tree so affected will show similar growths in other parts of the trunk or branches, whereas none of its neighbours are affected at all. Wens have been procured from Australian red cedar (cedrela)—not related to the true cedars, which are not so troubled—that completely surrounded the tree and exercised such pressure that the fibres of the stem were crushed out of shape and position and—to all appearance—thereby caused the decay. Such a wen, about 12 feet in diameter, had to be cut in pieces for transport. The sections, when the burr was sliced, were of extreme beauty, much harder than the ordinary planks, and displayed not the smallest imperfection such as the presence of any insect life would necessarily produce. Nor is the cause trauma in any form for the distortions may be seen in their earliest beginning, and in many parts of the trees. Also might be mentioned the ulceration that may be observed upon white gums, and which the normal principle of growth seeks in vain to repair. Quite possibly the principle of growth is connected with the infinitely small and so is for ever beyond research, but those who love knowledge for its own sake in relation to natural phenomena will find in these problems a life-long field for study. These questions are of intense interest to those who are brought into daily contact with them. It is so in the logging camps of Washington and British Columbia, in New Zealand, and the dense so-called scrubs of North Queensland.

Most Australian trees, no matter of what kind—excepting only the araucarias—have a tendency to sinuous growth, which greatly adds to the beauty of the timber, though not always to its utility. This is probably familiar in the figure of the pretty Queensland maple

(absurdly named), of which so much furniture and linings are now made. The twist is usually—not always—a right-hand screw, why, nobody knows, nor can any one explain why almost all climbing plants, though not all, form a right-hand screw, in common with almost all sea shells.

Again, our timber getters are much interested as to what enables the hanging vines to pump, not sap, but water from the ground, in volume, up a perpendicular stem 200 feet and more, to be evaporated on the top of the forest. The sap you must not touch, and it is contained in the bark of the vines, astringent and acrid, but you may drink pure water out of a cut length of the wood of the vine. There is no answer to that problem, for capillary attraction does not apply. No more is known about that pumping system than is known of the cold light of the fungus and the firefly.

Another problem of interest as being close to nature in handling and regretfully destroying her loveliest and grandest handiwork. Many Queensland walnut trees have been cut down and shipped, but a difficulty hitherto insuperable prevents the continuation of the use of the wood, which is eminently suited to cabinet work, only that implements fail. In a very short time saws and planing knives lose their sharpness, and the work must too frequently be stopped. In short, the beautiful wood is uncommercial, and no one will handle it. The sap is strongly acid, but easily neutralized, so that is not the cause. The trouble is in the form of growth of the fibres; one might as well try to cut a Manila rope endways. The same applies to Queensland oak (not the Grevillea). Knowledge has not solved the problem, and so these glorious trees, 4 and 5 feet in diameter, are burned away instead of being utilized in the arts.

Some day in the fulness of time there will arise another Louis Pasteur who will study the pathology of plants, and perhaps rescue the beautiful and useful chestnut trees of France from destruction by a mysterious malady which now afflicts them. Pierre Loti, the romanticist, guesses it to be a deadly fungus which wreaks the mischief. It is quite possible, for it may spread through the sap or otherwise into the system of the trees. In that connexion may be adduced a curious fact which if followed up might throw some light upon the influence of poisonous mycocetes upon the human (or other) respiratory system. It is customary in London and elsewhere to keep sliced veneers in moist chambers, and marquetry inlays in closed boxes or cupboards. The operatives well know that to open these receptacles without precautions may mean a sudden attack of catarrh. It is instantaneous and resembles the oncoming of the so-called influenza, of which in the United States, Eastern and Western Canada, Australia, and elsewhere, I have had an unhappily wide opportunity of observation. It is only a guess, but the diffusion of spores wholly invisible to the present microscope could account for the astonishing spread of the malady in remote and unvisited districts of Northern Canada and Alaska.

Another disease of plants which causes loss and annoyance is the deposition of stone in the substance of the tree known as Bombay rosewood. The lumber is very handsome, being of a rich purple, or dark blue with a reddish tinge, which colour is difficult to preserve under

treatment by polishing. The wood is hard, and its peculiarity is that the layers of fibre do not possess a good lateral cohesion—are easily separated, and must not be sliced, as already stated. Sometimes the stony deposit—very likely calcareous, but we never analyzed it—extends from the stump many yards into the body of the tree continuously. In that case there are usually further deposits through much of the trunk between the fibrous laminae. It is then impossible to saw up the logs. A frequent trouble with trees of many kinds is that, during growth, stones large or small have been enclosed, or chains and other objects, which the saws only discover. But the actual deposition of stone by the organs of the tree itself is known to us only in the case of the Bombay rosewood.

The properties of trees and their lumber are most diverse, one of the damars, Kauri pine, having the property of shrinking endways when cut into boards or baulks. In this it differs from its congeners, and indeed from most or all other woods. Why, no one knows, but the quality must be taken into serious account or disaster may follow. Other woods must be dried with great caution, and with every regard for their peculiarities. During the Great War a sudden demand arose for certain woods, more especially spruce, and no substitute for it was discovered. I have inspected great quantities of spruce in the State of Washington and in British Columbia, which were purchased for, ostensibly, use in aeroplanes. Much of it was wholly unsuitable, as the suppliers themselves considered, and were not slow to declare. But the Government buyers were often quite inexpert and incompetent. Afterwards I saw in the great aeroplane factories in many parts of England the kinds of spruce actually used in the cabinet-making departments, and would say that the material as finally chosen was admirably suited to the work, well handled in the construction, and the wood well inspected. Only once was I shown a substitute—cypress—and was asked for an opinion by the superintendent. "Altogether unsuitable and dangerous," I said. The official said it had been authorized, but suddenly an order had come to take out every particle, no matter whether in finished or unfinished parts or even completed 'planes.

ADHESIVES.

In the Philadelphia *Saturday Evening Post* of 3rd May last is a long article, "What we Learned about Wood," that is to say during the period of the war. I have not quoted from it, but it will be found interesting. What I do know is that not a single fighting 'plane of American construction was used in France up to the end of the war, whereas the cabinet shops of England, pianomakers amongst them, quickly adjusted themselves to turning out the most perfect work the world has seen. A friend of my own in London, who is a veneer cutter on a large scale, indeed the chief dependence of the war authorities in that important connexion, invented a special adhesive for securing the laminæ of aeroplane propellers. He happens to be a Fellow of the Chemical Society, and was very early on the search. Many splendid lives had been lost because of propellers bursting apart, the strain being severe during extreme exposure to cold and moisture, with rapid changes of temperature.

For more than a dozen years I have watched a process of building up ply-stock by a vegetable adhesive which has largely displaced animal gelatine. The development has been chiefly by experiment, for chemical analysis shows no difference between successful and unsuccessful kinds of this adhesive, and there has been consequently much loss of time, besides waste and disappointment when departures were made from proved substances. We believe that the one reliable preparation is made from cassava-root, and that other kinds of starch have given unsatisfactory results. I have often inspected the apparatus for glueing, which is much simpler, and the methods of handling much less exacting than those we are compelled to follow in dealing with gelatines. Kneaded in a particular way, and treated with alkali in the prescribed manner, this vegetable glue is tested as to viscosity by being drawn into threads whose tenuity is remarkable. The filaments are finer than those of a spider's web, we are told, and so indeed they appear. Were it possible to examine the molecules it would be an interesting study to find out and display what are the qualities which permit of such amazing cohesion. What can be the attraction that holds them together? At all events, being of vegetable origin, the fibres of the sheets of veneer are joined by a substance almost homogeneous with their own, and thus the processes of polishing are less likely to be spoiled than when a heterogeneous substance, as gelatine, is used. In both cases the adhesive penetrates the pores of all end-grain, of which, as already stated, figured ornament chiefly consists. Gelatine is not a suitable base for any polish, whereas the starch in a specially chosen form as just described is an approximation to wood-fibre, and probably for that reason does not cause the troubles which so often arise from gelatine. The tenacity of this adhesive is great when applied to sheets, and although it is sometimes applied to main joints, that is, to joining lumber itself, the practice is as yet far from general. It is expected, however, that its use will be constantly extended. In both cases—vegetable and animal glue—the ply-stock is subjected to such pressure as just stops short of crushing the cores which are to be veneered. But with this difference that, whereas the cores and the glue in the case of gelatine must be kept at a warmth of about 160 deg. Fahrenheit by the use of heated cauls of metal, preferably zinc or aluminium, the prepared starch is used cold, so that without risk the operation may be interrupted by the lunch hour, or indeed left over till next day. In effect the process is simpler, quicker, and in some respects more certain than the older method of using hot gelatine as an adhesive. There is no question as to the success of the system, and the only dangers introduced were when users stepped aside from knowledge that was adequately tested by practice, and rashly accepted quasi-scientific assurance that other substances were essentially the same. There are many adhesives, each with its uses, but the two herein described are preponderant in woodworking.

Before leaving the subject of lumber and its joining there are characteristics of curious interest attaching to certain timbers. Some are so glassy or oily that ordinary glue will not attach them. Another can hardly be broken transversely, but under extreme strain will split or tear lengthwise. European beech will resist torsion. Walnut has the property of holding screws particularly well, and hence its special applicability to gun stocks. A few woods are immune from the attacks

of white ants, as our cypress pine. Spiders will not form cobwebs upon chestnut, as doubtless many of you have been shown in ancient churches, and for which reason it is said the timber was chosen. Borers attack many woods, but usually leave highly-scented timbers alone.

One of my friends is director of a large match factory, and I suggested to him to try logs of candlenut trees, whose glorious foliage is so observable in the dense forests of Queensland. The wood is straight, snowy white, easily obtained and easily handled. Exposed to wet it perishes first of all timbers, but it is durable if kept dry. It was to be peeled into veneers out of which both boxes and matches are made. All was lovely but for an unforeseen and fatal objection. The fibres are hollow, the whole substance of the tree being merely a bundle of exquisitely straight and minute tubes. When lighted each and every match exuded smoke at the opposite end. Quite harmless, but no one could be expected to buy them.

The colours of many woods are fugitive, whilst others change sadly in the course of drying. Under no treatment except artificial staining is the full beauty of the wood preserved as when first sawn or sliced in its own sap. A superb yellow is displayed by the sovereign-wood of the Queensland scrub, which is quite permanent, but the blue of Bombay rosewood, the rich brown of black bean and the lovely pink of Cardwell maple either disappear under the polishing process or become tame and dull. If any kind of stain or pigmentation is used the other beauties of light and shade are obscured or levelled out. It is best, therefore, to leave the natural ornaments in their reduced appearance, and indeed in that state they are often very handsome. The private office of a friend in Vancouver is lined with some fine specimens of figured Douglas fir. A newly-arrived London decorator, looking over them critically, said, "The grainer who did that work did not know his job." The owner replied, "In this case the Almighty was the artist."

Whole volumes have been written upon this heading, but I shall give slight mention. In America the method of polishing with shellac dissolved in spirits is rarely used, and is regarded as uncommercial. A more laborious system of varnishing in several coats, cutting each down with pumice and water, is still in vogue. The last coat is polished by hand, demanding patience and skill. The system is costly, and not wholly reliable, consequently by general agreement amongst producers of cabinet work, a dull finish is now in vogue in all the States, which on the whole is best for the ultimate users of the goods.

In Europe of late years a change has been made in shellac polishing by using both oil and spirit varnishes in the process. This, however, demands special knowledge and practice. The result is increased durability in the protective coats, and a more permanent surface and gloss. To preserve the beauty of the figured ornament, and as far as possible the colour of the wood, many forms of treatment have been used. Tallow, petroleum, linseed, soya, and other oils have been applied to greater or less failures, usually greater. During the process of polishing, sulphuric acid in 10 per cent. solution, neutralized subsequently by precipitated chalk, has been applied as a regular practice. In general the effect has been to induce varying degrees of disgust. Germany can fairly claim these inventions, as also other polishing methods that were persisted in for years and decades, to be finally abandoned.

An American method carefully tested and applied upon a scale of actual production, is, or was, to plunge completed cabinet work, or at least finished parts, into tanks of varnish, and then by automatic machinery to gradually elevate the object, having regard to the surface tension and a viscosity previously calculated. An even temperature is easily provided, but there are great objections to the method itself.

Small objects of wood, as doubtless you are aware, are treated by frequent mechanical dipping in celluloid preparations, continued for weeks or months. The Du Pont de Nemours Company of America, who were the chief suppliers of explosives to the Allies, and thus realized avaricious dreams beyond your wildest guess, have applied part of their plant and profits to utilizing their chemistry for peaceful pursuits. Amongst these is the production of varnishes of quite novel character, and they have not the unfortunate inflammability of celluloid.

But of all varnishes one stands pre-eminent as enduring the test of ages, and because of its beauty united to great power of resistance. That is the Japanese lacquer, perhaps wrongly so called, because we understand lacquering to be varnish floated by application of heat. I once hired a Japanese artist to teach me the use of their varnish, known to them as "urushi," the juice of a tree of one of the Rhus family. The practice has come down for centuries, how far back I do not know, but certainly the lacquer resists molecular change beyond all others. We have still, I believe, some of the material in its original packages, a dark-brown liquid that can only be used according to long-settled rules. It is too long a story to relate, but the strangest of its many idiosyncrasies—if we may use the word—is that all the work must be carried out in a cool and thoroughly moist atmosphere, a condition that would be destructive to all other varnishes that we know of. Neither shellac, nor copal, nor Kauri gum, nor celluloid will tolerate cold moistures in the application of them. Yet in the preparation of urushi, to my surprise, water was mixed in the preparation of the material for the ground work, which the artist explained would presently separate itself all at once. This indeed occurred, the water suddenly flowing out on all sides and leaving the other materials, whilst they are still being blended with a palette knife. This ground layer, together with the wood to be lacquered, was placed in a very moist chamber for days to harden, just what would not happen with other varnishes. And sure enough it became very hard and fit for cutting down. The subsequent processes consist of adding coats of urushi coloured as desired and each laboriously cut down to smoothness.

As already said, the lacquer will last indefinitely, will resist all ordinary exposure, is unaffected by boiling water and temperatures that would destroy other covering. I was informed that the only practical diluent is the juice of a fruit tree quite different to the Rhus itself. So far as I am aware the only successful attempts to carry out the process in Europe were made before the war in Austria, but it may be doubted that the experiments have been brought to actual utility.

I have not at hand my books of reference, and so have to quote from memory. Professor Friedländer, of Königsberg, author of *Sittengeschichte Roms,* often cited by Mommsen, deals shortly with the mentions of cabinet work in the Roman Imperial period. Amongst

them it is stated that Narcissus, the multi-millionaire secretary of the Emperor Claudius, possessed a very fine table of thuja wood valued at 1,000,000 sestertii, which in actual gold currency of his day would equal 10,000 sovereigns. It was, however, only veneered, whereas another existed which was said to be solid and of much higher value. The timber was brought from the Atlas Mountains. We have other records showing that choice woods were held in high esteem, and we know that red cedar was regularly brought from the Orient in the form of packing cases bound with cords so that it might not be spoiled by nails. The practice lasted to our own times.

There exist some drawings of ancient furniture of elegant form, and we have even specimens of woodwork so well preserved from Roman times that the system of construction can be perfectly followed. A carriage wheel in good preservation, found at the Roman fort of Newstead in recent years, shows an elm hub, ash spokes, bent rim in one piece with its one joint cleverly protected, the iron tyre being rounded and shut on to the bent ash rim, just as in these days. For the axle is provided a double instead of a single box, whilst the whole workmanship is light, elegant, and admirably proportioned. The spokes are neatly turned, and are mortised into hub and rim in the most approved style. The wheel could not be made better, and would not be made as prettily, in the present day. Inasmuch as such perfection was attained in the time of Hadrian, himself a capable designer, born at Nemausus, a centre of advanced Gallic art, we can partly estimate the high quality of cabinet making at that epoch. For excellence in coach-building obviously must have been reflected in household furnishing, because both belong to the school of joinery. I found the museums at Nismes to afford a delightful study in household objects of great beauty, and they have surely had an influence upon French taste during the centuries.

Thus we see that the knowledge necessary to the art of cabinet making and joinery in general has taken a long time to accumulate, whilst we can remain assured that in previous civilizations a high degree of proficiency was attained.

Insect Enemies.

A CALIFORNIAN EXPERIENCE.

Insects introduced from Australia. □ Combating Beet Leaf Hopper.

By E. J. VOSLER.*

Before going into an account of the writer's trips to Australia, which were made primarily for the purpose of securing enemies of the beet leafhopper, Eutettix tenella, Baker, it might be of interest to give a brief summary of the work of this insect in California and elsewhere, and the reasons for undertaking this investigation.

For some years it has been known to entomologists that the leafhopper, Eutettix tenella, has been associated with the disease known as curly-leaf, which is destructive to the culture of the sugar beet. In 1909 the United States Bureau of Entomology published a bulletin, by E. D. Ball, on the leafhoppers of the sugar beet, in which a detailed account was given of the curly-leaf disease in the inter-mountain States, and the role Eutettix tenella plays in the transmission. Ball states in this bulletin that as early as 1897 the sugar beet crop around Lehi, Utah, suffered a serious loss. It was not until 1905, however, that it was noticed, in fields where curly-leaf was prevalent, that large numbers of the beet leafhopper were present, and it was first suspected that this leafhopper might in some way be connected with the diseased condition of the sugar beets. The study of this disease was begun by Ball in 1905, and continued in 1906 and 1907. The results of his work show that the curly-leaf condition of the beets appears soon after the leafhoppers are found in the fields, that the severity of the disease is contingent upon the numbers of this species present, upon the time of their appearance and upon climatic conditions. Investigations continued by Ball, Stahl, Smith and Boncquet have definitely proved that the bite of this particular leafhopper is necessary for the transmission of the curly-leaf disease to healthy beets. Just what the casual organism of curly-leaf is has not been determined. Recently Stahl and Carsner have published the information that leafhoppers which have never fed on beets affected by curly-top will not produce the disease on healthy beets. Sufficient proof has thus been obtained, pointing to Eutettix tenella as the guilty party in the inoculation of sugar beets with curly-leaf.

In beet leaves first affected with curly-leaf there is a thickening of the smaller veins, the undersides presenting a roughened appearance. The edge of the leaf curls up and finally the whole leaf curls. As the disease advances the smaller veinlets grow still larger, and irregular, knot-like swellings become noticeable. In some cases the beets shrivel and die, in others they partially recover and a new set of leaves develops. The sugar content remains low in all affected beets, and consequently the loss is greater than usually is supposed.

The full-grown leafhopper is a small, pale yellowish-green insect about an eighth of an inch in length. The eggs are elongate, slightly curved, tapering at one end and white in colour. They are deposited mostly in the stems and the midribs of the beet leaves. The nymphs are whitish with dark markings on the dorsum. There appears to be only one generation a year. The adults appear in the fields in the spring and deposit their eggs in the beets. They will breed in a number of native Chenopodiaceæ besides the sugar beet, including Atriplex, Russian Thistle, Sarcobatus, &c. They have been found on several weeds that are not Chenopodiaceæ. The life history of this insect in California is now being studied by Severin, of the State University, and Stahl, of the United States Bureau of Entomology.

*Foreign Collector, Insectary Division, Californian Commission of Horticulture.

INSECT ENEMIES.

The leafhopper is generally distributed throughout the south-western parts of the United States. It has always been supposed to be a native of this part of North America. Recently a trip by Boncquet to Argentina revealed the presence of Eutettix tenella and the curly-leaf disease in the beet fields of that country, so the origin of the insect remains obscure.

Losses from the ravages of the curly-leaf disease have been enormous, not only in California, but also in the other western States where the sugar beet is grown. Of course, the amount of damage will vary from year to year. In the year 1914 the loss reported by one sugar company alone in California, and in a single small valley, was given as 1,000,000 dollars. The total loss from all beet-growing sections will go far into the millions. In some parts of California the disease is so bad that the growing of sugar beets has been practically discontinued, and sugar factories abandoned.

CONTROL MEASURES.

Experimental work in the control of the beet leafhopper has been carried on by the United States Bureau of Entomology, the Utal Experiment Station, the University of California, and the various sugar companies, but no successful measure has been developed whereby the leafhopper can be checked. The early planting of sugar beets so that the beets are well started before the leafhoppers appear in the fields gives the best results. Spraying the beets with various washes such as blackleaf—40, kerosene emulsion and soap solutions has been tried. Difficulty in destroying the adults with a spray, and the fact that the undersides of the beet leaves cannot be thoroughly sprayed make this method of control of doubtful value. A variety of resistant beets has not yet been developed. The destruction of native weeds on which the leafhopper may breed surrounding beet fields is practically impossible in many cases.

Because of our inability to control the beet leafhopper by artificial means, the possibility of controlling it by the introduction of natural enemies was given the attention of the State Commissioner of Horticulture. Later, in 1916, through the co-operation of the Spreckels Sugar Company, the State Commissioner arranged to send a collector to foreign countries to investigate parasites of leafhoppers with a view to introducing them in the beet fields of this State as an aid in the control of this pest. It was thought advisable to explore Australia first, as many species of leafhoppers are present in that country which are known, through the researches of Koebele and Perkins, to be attacked by numbers of natural enemies. Also Australia presents in its flora many species of Chenopodiaceæ, to which family the sugar beet also belongs. The writer was selected to conduct the investigations, and left San Francisco in January, 1917, for Sydney, Australia, arriving there on 22nd February.

The introduction of a Dryinid parasite of a leafhopper abundant on Eragrostis villosa, in eastern New South Wales, occupied much of the time of the writer during his first trip. A number of Wardian cases, filled with parasitized leafhoppers of this species, was sent on several steamers to the Insectary Division at Sacramento, but only one female Dryinid came through in a living condition. This was placed in a case with beet leafhoppers, and was observed to oviposit in them, but unfortunately no parasites were reared. The parasitism by this Dryinid on the above leafhopper in New South Wales was approximately 7 per cent. In Victoria, investigation of saltbushes for leafhoppers was started, and near Sunshine, Victoria, the writer found a small leafhopper, abundant on a low-growing saltbush (Atriplex muelleri.) This leafhopper was parasitized to the extent of 85 to 90 per cent. by two egg-parasites, Ptergogramma acuminata and a Mymarid. Stems of the Atriplex containing the parasite eggs of this insect were sent in cold storage on the Oceanic steamers to California, and from these a number of egg-parasites of both species were obtained. These were placed on the eggs of Eutettix tenella and were seen to oviposit. As Ptergogramma acuminata attacks several species of Jassids, the chances for its breeding successfully on the beet leafhopper were thought to be good. Winter stopped the work of collecting the egg-parasites in Australia, and the writer left for home on 15th June with the intention of returning on the approach of summer to continue the shipment of egg-parasites, provided additional funds were secured for the carrying on of the work.

The increasing demand of the sugar made the continuance of any work which might increase the yield of sugar beets doubly advisable, and an appropriation was obtained from the State Board of Control sufficient to insure the furtherance of the project. During the interval before the return of the writer to Australia much time was spent in rearing large numbers of the beet leafhopper. The greenhouse at Fort Sutter was placed at the disposal of the Insectary by the Superintendent of Capitol Buildings and Grounds, and the leafhoppers were soon breeding in numbers sufficient to insure a supply of eggs upon which the Australian parasites could be placed upon their arrival.

The writer left San Francisco 1st January, 1918. The port of Sydney, Australia, was reached on 22nd January. Being somewhat acquainted with Australia from the previous trip, little time was spent in New South Wales excepting to call on the Entomologist of the New South Wales Department of Agriculture, Mr. W. W. Froggatt, and his assistants, who had given me much aid during the previous expedition, and to collect a small shipment of beneficial insects to go out on the returning steamer.

This shipment consisted of several boxes of parasitized golden mealybugs, Pseudococcus aurilanatus, a pest of Norfolk Island pines in southern California, and a box of twigs infested with the black scale, Saissetia oleae, on which two species of internal parasites were breeding.

After the departure of the steamer, the writer left for Melbourne, where he made his headquarters for the remainder of his stay in Australia. From this point shipments of parasitized material were made every three weeks to connect with the Oceanic steamers plying between San Francisco and Sydney.

An examination of the saltbushes in the State of Victoria, South Australia, and in parts of New South Wales, was made for leafhoppers and their parasites. Several species of leafhoppers were found on these saltbushes, and, besides, some thirty species of Jassids were collected on grasses in Victoria, New South Wales, and Queensland, but are still undetermined.

By far the majority of the saltbushes were uninfested with leafhoppers. In all the writer's collections in Australia the only parasites which gave promise of being of value in checking the beet leafhopper were the egg-parasites, Ptergogramma acuminata and the Mymarid. Consequently his main attention was given to the collection of these parasites in large numbers so that a fair trial could be given them in the laboratories of the Insectary at Sacramento. As previously stated, shipments of the stems of the Atriplex containing the parasitized eggs were forwarded regularly to California on board the Oceanic steamers. Intervals between steamers not occupied in collecting these egg-parasites were employed in searching for additional saltbushes, and for parasites of some of our citrus-feeding insects.

The saltbush, Atriplex muelleri, was badly infested with a leafhopper in the vicinity of Sunshine, a small town near Melbourne. Nearer Melbourne, where the saltbush was growing in more profusion, the leafhoppers and their parasites were quite scarce. The parasitism at Sunshine by the two-egg-parasites, Ptergogramma acuminata and the Mymarid, was close to 90 per cent. A careful examination of hundreds of nymphs and adults of this leafhopper showed no signs of parasitism. Two hundred miles north of Melbourne, on the Murray River, I also found the same saltbush infested by this leafhopper, but the percentage of parasitism by the same egg-parasites was much lower.

METHOD OF PACKING.

Two days prior to the sailing of the steamer the stems of the Atriplex were collected and placed in wooden boxes, each having a cubic content of about two feet. Boxes of this size were chosen because of their lightness, and consequent ease of handling, and also because of the liability of the stems to mould in the centre if packed in larger boxes. The boxes were wrapped with two or three thicknesses of light muslin, and the seams pasted down to prevent the exit of any insects during the voyage. From Melbourne the cases were sent to Sydney by passenger train and placed immediately on board in the cool-room of the steamer at a temperature of 45° F. A letter to Wells, Fargo and Company, at San Francisco, enclosing the bill of lading, was despatched on the

same steamer. An official of Wells, Fargo and Company met the steamer at San Francisco and sent the shipment on the way to Sacramento, where it was opened in the insect-proof rooms of the State Insectary.

It was found, as a rule, that the stems of the saltbush came through in good condition. The egg-parasites were still in the larval and pupal stages, and the three weeks in the cool-room of the steamer apparently did not affect their vitality to an appreciable extent.

The most difficult part of the introduction of the delicate parasites was to find some means of rearing the adult insects before the stems dried up and crushed the eggs of the leafhopper in which the parasites were breeding. Various methods were tried, such as placing the ends of the stems in water, in plaster of paris blocks under glass, and by dissecting out the eggs which were kept at an even temperature in an incubator electrically controlled. Only a few adults were obtained by these means. After further experimentation a plaster of paris block, about eight inches long, six inches wide and two inches deep was cast. Through the centre of this block a two-inch hole was left, over which, about halfway between the top and bottom, a piece of closely-woven muslin was stretched. The eggs of the leafhopper containing the parasites were dissected from the stems and placed in the plaster of paris block on the muslin. The block was placed in a tray of water. A small piece of glass was used to cover the top of the block and the plaster of paris absorbed sufficient water to keep the eggs moist until the parasites emerged.. A little difficulty was experienced because of the excessive moisture which would collect around the eggs and drown the parasites as they emerged. This was obviated by cutting an opening in the glass on the top of the block and covering it with muslin, and by filling with paraffin the pores in the muslin on which the eggs were placed. The parasites as they emerged were removed from this incubation chamber to cages in the Fort Sutter greenhouse, containing beets heavily infested with the eggs of the beet leafhopper.

Since each shipment of the parasite material was too large to permit of the dissection of the parasitized eggs immediately after its arrival at the Insectary, most of the boxes were placed in cold storage until needed. This plan worked very well. It is interesting to note how long material of this kind can be held in cold storage. The last shipment made from Australia was collected on 11th May near Melbourne. It was placed in the cool room on board the steamer on 14th May, at Sydney. It arrived in San Francisco on 3rd June, and in Sacramento on 4th June. It was placed in cold storage again on 4th June, and the last box removed from the cool room on 6th July. From eggs dissected from this latter shipment the last Ptergogramma was reared on 13th July, or nearly two months from the time of collection.

As stated above, the delicate parasites were immediately removed from the incubation chambers after emergence and placed in the cages at Fort Sutter, containing an abundance of the eggs of the beet leafhopper. The movements of these parasites were carefully watched, but they showed no desire to oviposit in the eggs of the leafhopper. Dissection of hundreds of eggs of the beet leafhopper from the cages in which the parasites were liberated revealed no evidence of parasitism, and no parasites developed. The two species were reared in sufficient numbers to give them a fair trial, so we must conclude that they find Eutettix tenella an unsuitable host.

The culture of sugar beet is only in the experimental stage in Australia. A small factory run by the Victorian Government for the production of beet sugar is located at Maffra, Victoria. The factory just now seems to be in a fair way to demonstrate the production of sugar on a paying basis. This is the only factory for the production of beet sugar in Australia. The capacity is about 400 tons. It will run through about 40,000 tons of beets during the season. In Queensland the Colonial Sugar Refining Company is engaged in the large scale production of cane sugar, and it is with sugar cane that the sugar beet must compete in Australia.

At odd times the writer, in his researches for parasites of the beet leafhopper, found an opportunity to investigate some of the insects injurious to citrus culture in Australia. Where those insects were identical or closely related to those that are attacking our citrus in California, a study was made of their parasites with a view to introducing them in our own groves.

PARASITES OF THE BLACK SCALE.

The black scale (Saissetia oleæ) is not considered to be a pest of prime importance on citrus trees in Australia. Whether this is due to the natural enemies of the insect established in that country the writer does not know, but various ornamentals such as pittosporum, oleander and elm were at times heavily infested in the botanic gardens at Adelaide and Melbourne. In the citrus groves visited by the writer only an occasional tree was seen to be infested to any extent. On these trees the predacious moth, Thalpochares cocciphaga, the internal parasites, Coccophagus sp., and Aphycus lounsburyii, the egg-parasite, Scutellista cyanea, and various ladybirds were found in abundance.

The two internal parasites, Aphycus lounsburyii and Coccophagus sp., were collected at Parramatta and Gosford, both in New South Wales, and were received by the Insectary at Sacramento in living condition. As climatic conditions here are similar to those where these parasites were collected, there should be no difficulty in getting them established; particularly Aphycus, which seems to be the more promising.

The Insectary force is now engaged in rearing these parasites in sufficient numbers to permit the introduction of them in California orchards.

One of the most important enemies of the black scale in Australia is the predacious moth, Thalpochares cocciphaga. The larva of this moth feeds on all stages of the black scale, but seems to prefer the eggs. It is a case bearer, making a case of the remains of the host, under which it moves along the twigs in search of additional prey. As it breeds under conditions similar to California we can see no reason why it should not do well here. It is heavily parasited in Australia. A number of full-grown larvæ of Thalpochares were collected at Parramatta, New South Wales, just prior to the writer's departure from Australia, and placed in cold storage on board the ship. From these, seventeen moths were reared at the Insectary. They were confined in large test tubes and fed with honey. Eggs were first deposited on 16th July. On 24th July the first larvæ emerged. As soon as possible after emergence the larvæ were placed on citrus cuttings heavily infested with black scale, egg-stage. The cuttings were inserted in potato tubers to prevent their drying out too rapidly. As soon as the larvæ ate the eggs from one lot of cuttings they were transferred to another until they reached maturity, when they were removed to a vial to await emergence as adults. Other methods of rearing were to place the larvæ on oleanders infested with black scale and in vials filled with black scale eggs. All were successful. The first adult of the new generation emerged on 9th September, a little over three months after their arrival. The new generation gives promise of a large increase in numbers, and we hope that two or three generations more in the laboratory will be sufficient to enable us to introduce them in the groves. The Thalpochares is the most promising of any of the material brought from Australia.

PARASITES OF MEALYBUGS.

No specimens of the citrus mealybug, Pseudococcus citri, were taken during the writer's visits in the citrus orchards of Australia. A species closely resembling citri was found infesting a broad-leaved ornamental in the Botanic Gardens at Brisbane, Queensland. From this mealybug the Sicilian mealybug parasite, Paraleptomastix abnormis was reared. This parasite is the one which the Insectary Division collected in Italy some years ago, and which the Insectary has successfully colonized in the citrus orchards of Southern California. This parasite was undoubtedly introduced from Italy into Australia through the importation of plant material infested with mealybugs parasitized by this little insect.

Only two other species of mealybugs were taken on citrus trees, Pseudococcus longispinus and Pseudococcus sp., the last being larger than any of our citrus-infesting species. None of these three mealybugs are considered to be at all destructive; in fact, in the Epping and Gosford districts of New South Wales a two days' inspection of the orchards revealed only two groves to be infested. Most of the young mealybugs in these groves were parasitized. Just prior to the sailing of the steamer the writer spent a day collecting parasitized mealybugs. Approximately one hundred specimens were taken. From these, two

species of primary parasites, Leptomastix sp., and Anagyrus sp., were brought to the Insectary in living condition and liberated on the citrus mealybug, Pseudococcus citri, the citrophilus mealybug, Pseudococcus gahani, and Pseudococcus maritimus. Although Leptomastix sp. was seen to oviposit in the citrus mealybug, none was bred from it. A large Leptomastix bred from a shipment from Victoria was seen to oviposit in the citrophilus mealybug, but we did not succeed in rearing any parasites from the material.

The golden mealybug, Pseudococcus aurilanatus, is becoming an important enemy of the Norfolk Island pines in Southern California. As Australia is the home of these trees, the writer was instructed to locate any natural enemies of this pest. At Manly, New South Wales, examination of the Araucarias showed that the principal factor in the control of this mealybug was the ladybird, Cryptolæmus montrouzieri, which is already of considerable assistance in controlling our California mealybugs. Internal parasites were also in evidence. Material collected at Manly and placed in the breeding cages at the Insectary produced the internal parasites, Pachyneuron sp., a small Encyrtid, and Tetracnemus sp. These were released upon the golden mealybug. It is too early to tell just what the results will be from this importation. The Pachyneuron was also released on Pseudococcus maritimus and oviposited readily in this species, but did not develop. From Pseudococcus acaciæ, infesting Acacia near Melbourne, Thalpochares sp., a predacious moth closely resembling the predacious moth of the black scale, was reared in some numbers. The moth laid eggs in the rearing cages at the Insectary, and the larvæ were placed on the egg masses of Pseudococcus citri, but it was found that this mealybug was not a suitable host for the moth. From material containing Pseudococcus albizziæ, collected near Melbourne, a small Encyrtid was reared at the Insectary which was placed in a cage with our Californian mealybugs, in the hope that it might find them a suitable host. No parasites have yet emerged from this cage. A ladybird, Rhizobius plebius, collected in Victoria feeding on P. acaciæ, was also introduced as a mealybug destroyer, but we were unsuccessful in rearing it.

Several specimens of Midas pygmœus were also reared from this material. The Midas is a small black ladybird with red blotches on the elytra. A colony of this ladybird was collected on the first trip to Australia and brought in living condition to the Insectary. It breeds readily on the citrus mealybug, and it is believed that it will be a promising addition to our imported enemies of mealybugs.

Personal.

MR. F. LEVERRIER, K.C.

In this issue is published a photograph of Mr. Frank Leverrier, K.C., chairman of the New South Wales Committee of the Institute of Science and Industry. Since the inauguration of the movement for the formation of a permanent institute, Mr. Leverrier has taken an active interest in the work of the temporary organization, and has devoted a great deal of his time to the furtherance of its objects.

Had he not become an eminent lawyer, Mr. Leverrier would in all probability have made his mark as a man of science. Two careers were open to him at the completion of his University course, for he distinguished himself in both arts and science. He graduated B.A. in 1884, and B.Sc. in 1885. However, although the law claimed his first and most serious consideration, his interest in science was never abandoned. In "Whose Who in Australia," Mr. Leverrier's recreations are given as "science and cabinet making."

Although born in Sydney, Mr. Leverrier spent most of his youth in France. He returned to Sydney at the age of fourteen, and attended the Fort-street Public School until entering upon his studies at the University. In 1888 he was called to the Bar, and soon rose to a prominent place in equity jurisdiction, and became also a recognised authority on patent law. He held the Challis Lectureship in Law at his Alma Mater from its foundation in 1890 until his election as a Fellow of the Senate in 1907, in succession to the late Mr. H. C. Russell, who was Government Astronomer of New South Wales. Mr. Leverrier still remains a Fellow of the University Senate, having been re-elected by the graduates at the 1912 and 1919 elections. In 1914 he was elected Vice-Chancellor, and occupied that position until 1917. He was appointed a K.C. in 1911.

Owing to his interest in and wide knowledge of science, Mr. Leverrier has gained a peculiar distinction at the New South Wales Bar, inasmuch as very few cases involving any intricate questions of science have been fought out in which he has not appeared as counsel on one side or the other. When the Electrical Association of Australia commenced the investigation of electrical standardization problems, Mr. Leverrier was appointed to represent the Institute of Science and Industry on the New South Wales section of the committee. He was chosen as chairman of the section at its first meeting, and has held that position up to the present time.

Reviews.

Beverages and their Adulteration, by H. W. Wiley, M.D., Philadelphia, P. Blakiston's Sons and Co. The book is divided into sixteen sections, and deals, not only with alcoholic beverages, but also with water and mineral waters, both artificial and natural, with soft drinks and fruit juices, and with coffee, tea, and cocoa. The author points out that, in view of national prohibition in the United States, many persons have suggested that a description of alcoholic beverages may be out of place. He considers, however, that just the contrary is the case, and that any one who desires all the information possible in making up his mind on this question will certainly be helped by a knowledge of the origin, manufacture, chemical composition, and geographical distribution of the various forms of alcoholic beverages, both fermented and distilled.

In view of the rapidly increasing use of fruit juices in America, prominence has been given in the book to that subject. A somewhat full description is also given of many types of "soft drinks," and there is a lengthy list of the so-called medicinal preparations, which consist chiefly, or very largely, of alcohol. The ease with which the unfermented juice of the grape may be pasteurized or sterilized, and kept indefinitely, has caused the industry to grow rapidly. For red-grape juice, the grapes are crushed, but not pressed. The crushed grapes are taken into large heating caldrons, usually made of aluminium, and furnished with a steam jacket. The temperature of the crushed grape is carried to about 175 degrees F. for a period of 15 minutes, the mass being well stirred during this period of heating. The purpose of heating the grape juice is not only to pasteurize it, but also to extract the red colouring matter from the skins. After extracting the colour and pasteurization, the juice is separated from the pulp and conducted into the containers, which are used for storage. Sometimes these containers are barrels, but more often glass carboys. The containers are properly sterilized before the pasteurized juice is admitted. The bungs are also sterilized and coated with wax or some other preparation, so as to make them air-tight. The juices are left in these storage containers until complete sedimentation takes place and the liquid is clear, when they are siphoned off carefully, so as not to disturb the sediment, into bottles, which are sterilized and corked.

In discussing the therapeutic value of mineral waters it is stated that, while the widespread belief in the value of such waters is probably not well founded in fact, a few of the waters contain specific remedial agents, such as arsenic, and rare elements, such as radium, which are highly recommended for certain forms of diseases.

Johnson's Materials of Construction. Fifth Edition. Rewritten by M. O. Withey and J. Ashton. London, Chapman and Hall, 1919. 30s. net. This treatise, compiled some twenty years ago by the late Dean J. B. Johnson, College of Engineering, University of Wisconsin, has now been amplified and brought up to date by M. O. Withey, Associate Professor of Mechanics, University of Wisconsin, and J. Ashton, Metallurgist with the A.M. Byers Company, Pittsburg. The book sets out the essential information concerning the sources and manufacture of the principal materials, and furnishes useful data covering the more important physical properties and in the influence of various factors upon these properties. It shows the causes of defects and variations, and how they may be discovered, and furnishes an acquaintance with the technique of testing materials.

In arrangement, the new book differs markedly from the former work, which was somewhat cumbersome in this respect. The division into parts has been discarded, and related subject-matter has been more closely co-ordinated than in the previous work, as may be seen from the following:—In chapter I. is given a rather comprehensive synopsis of the principles of mechanics of materials. Chapters II. and III. deal with machines and appliances for testing, the technique of testing, and the utility of the various tests. Chapters IV. to VI. consider the characteristics, methods of identification, properties, and uses of the more important native woods, also causes of decay and means of preservation. Chapter VII. treats of the important stones, their constitution, durability, and properties. Chapter VIII. covers the manufacture and testing of structural clay products, together with their mechanical properties and uses. Chapters IX. to XII. deal with the nature, manufacture, methods of testing, and properties of the hydraulic cements, the limes, and the plasters. Chapters XIII. to XV. describe fully methods of making mortar, concrete, and concrete products; also the properties and uses of these materials. Chapter XVI. provides a brief summary concerning the utility of the principal metals, their ores, and the fundamental considerations governing their extraction. Chapters XVII. to XIX. treat of the reduction of iron from its ores, and the subsequent operations of purification and fabrication into final form. Chapters XX. and XXI. deal with the formation and structure of alloys in general, and the constitution of iron and steel. Chapters XXII. to XXIV. are devoted to a discussion of the properties and uses of wrought iron, steel, and alloy steels. Chapter XXV. takes up the manufacture, molding, constitution, and properties of cast iron and malleable cast iron. Chapter XXVI. treats of the production, properties, and uses of copper, zinc, aluminium, lead, tin, nickel, and their alloys. Chapters XXVII. to XXIX. cover the effects of temperature on metals, the causes and effects of fatigue, and the corrosion and protection of metals.

Diagrams and charts are extensively used for the presentation of facts and laws. These and the omission, wherever possible, of cumbersome tables, considerably add to the value of the book.

PROFESSOR RENNIE, M.A., D.Sc., Chairman of the South Australian Committee of the Institute of Science and Industry.

(For Biographical Notes, see page 250.)

SCIENCE AND INDUSTRY.

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

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Articles may be freely reprinted, provided due acknowledgment is made of their source.

More Facilities Needed for Industrial Research.

SHOULD an Institute of Science and Industry be established in addition to the universities and technical schools that already exist, to say nothing of Federal and State laboratories where the work might be carried out? In any case, ought not all such work to be provided for by the industries themselves? The best way to answer such questions is to consider, first, what is the work that should be done, and then what facilities for undertaking such work there are in existing institutions.

Our industries must become a substantial part of the foundation of our national life, their products must be of the best quality, obtained at the lowest legitimate cost; and to this end our own natural resources must be utilized as fully as possible, all waste being eliminated, the methods employed must be as reliable, as cheap, and as efficient as scientific knowledge, commercial information, and enterprising application can make them.

This requires, amongst other things, facilities for—

1. *The Development of Industries,* either by the improvement of existing processes, by increasing yields, lowering costs, improving quality of products, &c., or by the establishment of new industries to replace imported goods, to utilize resources or raw materials peculiar to our country, to prevent or utilize the waste products of existing industries, to meet new demands, or to substitute cheaper for more expensive materials.

2. *The Establishment of Standards,* to make possible the accurate checking of quantities, readings of controlling instruments, working efficiencies of machines, or quality of materials and products.

3. *The Supply of Information.*—All information relating to any industry should be easily available for the benefit of current work and as the preliminary step in any proposed investigation.

The existing institutions are—

1. *The Universities and Technical Schools.*—These are designed, equipped, and staffed entirely for the purpose of teaching. The men in charge of their activities must have a thorough knowledge of the fundamental principles of science—the foundation upon which all research, investigation, industry, or manufacture must be built. But they have not, and cannot have, also a knowledge of the engineering methods, the economic details, or the commercial intricacies that are involved in the successful application of those fundamental principles in the operation of any given industry.

2. *The Various Government Laboratories.*—These are equipped for the specific purpose of analyzing materials—agricultural, mineral, commercial. They are analytical laboratories designed solely for testing the quality or ascertaining the composition of materials or products.

Institutions such as these might undertake the question of standards, or the preliminary analysis of substances required as information in any investigation. Their exact scientific knowledge and their equipment are specially fitted for work of this kind, if such routine could be provided for without undue interference with their own proper work. Even then, it would be necessary to co-ordinate the work of the various centres to prevent overlapping, and to insure uniformity by the intercomparison of standards, &c.

None of these institutions, however, have any facilities for the commercial development of industries. For any work of this kind they would require special buildings, special equipment, and special men. The development of an industry requires not only the laboratory, with its test tubes, beakers, and balances, when the first suggestions of a process are born. It must also have the means for carrying out the process according to commercial requirements, using materials in quantities, and apparatus of the kind, that represent the operations of the actual industry. The possibilities, the difficulties, the requirements, and the working costs of an industry can never even be guessed by working in glass apparatus with a spoonful of material. In almost every instance the chief difficulties arise when the successful process of the laboratory is transferred to the small industrial testing plant. This is thoroughly recognised by all those industries that have established research departments. There is in every case a staff and

laboratory for analyses and investigations, and working in close touch with this, a staff and a small-scale industrial plant for developing and testing the suggested processes. It is this plant that involves the unending hunt for the commercial substitute for the glass beaker of the laboratory that faces the problem of handling materials, a problem unknown in the laboratory, and frequently the rock on which the process is most nearly shipwrecked.

No existing institution, university, technical school, or Government laboratory has any facilities for work of this kind. Would it not be better then to make the necessary additions to these institutions than to undertake the expense of a new institute?

For answer, examine a few typical investigations. The prevention of waste in the agricultural and pastoral industries—diseases of plants and animals, animal pests, plant pests, and plants that are pests. All this involves field or station work under constant expert supervision. No existing institution could take any such investigation under its wing; the only hope of success lies in the full-time attention of specialists.

Or take the problem of the application of mangrove bark or red-gum kino to the tanning industry. Analyses and suggested processes will originate in the laboratory, but the real question must be solved with real hides, working on real commercial methods. Work in conjunction with an existing tanyard necessitates the complete separation of the investigation from the commercial work of the tannery, and no industry can check its commercial production for the sake of an experiment. Its commercial routine, output, and obligations cannot be interfered with. Production and experiment must be kept entirely separate, and are so in all industries that carry research departments. And this means building and equipping an experimental section and providing a staff of expert workers.

No existing laboratories offer any advantage for this work—neither scientific, commercial, nor economic—for in addition to the objection of unsuitability there is the objection of economy. The establishment of a central Federal Institute would prevent the reduplication of equivalent establishments in each State. It would, as far as possible, make use of existing facilities, co-ordinate the work of the various sections so as to complete without reduplicating investigation; it would act as a central information bureau, collecting, indexing, and distributing information on a mutually arranged plan, and would work also with other similar organizations throughout the world. Its own laboratories would undertake work that could not be efficiently provided for elsewhere. Its staff would work in its own laboratories or in special stations or experimental sections, when the process suggested by the whole work would be tried out on a small industrial scale.

But, it might be objected, these experiments should be made by the person or firm interested. In some cases, where the advantage

would be reaped by the individual person or firm, that is true. But in most cases the benefit would be to a large number, and no single firm could undertake the investigation. For example—diseases of stock or of crops—a successful investigation would benefit the whole pastoral or agricultural community; the application of mangrove or redgum tannin to leather manufacture would benefit all tanners, bootmakers, and boot users; the successful seasoning of our timbers or the manufacture of paper pulp from timber waste would include in its results every one that used timber or read a newspaper, from the State that owned the forest to the citizen that owned the furniture.

Investigations may be divided into three classes—

1. Those of no immediate nor obvious utility. To this class belong the researches of "pure" science; they broaden the foundations on which all industries are built. Their real value is their addition to human knowledge, their contribution to the ultimate understanding of the universe. Their apparent value is their utility in laying the foundations of future industries. This work is the glory of our universities and scientists.

2. Those investigations which would benefit special firms. This kind of problem would not, as a rule, be brought to the Institute. Manufacturers would prefer to solve their own problems and keep their own secrets. If work of this kind were, in special circumstances, undertaken by the Institute it should be on a definite arrangement regarding costs and information obtained.

3. Investigations whose benefits embrace a large number of individuals or industries. These are of immediate and obvious utility. The research involves usually not so much the discovery of new truths as the application of old knowledge. These must be undertaken in some broadly co-operative way. The most satisfactory is that of the proposed Institute, dividing the work and cost with the States or industries concerned. This method has been in successful operation, although the Institute is heavily handicapped in carrying out the work by its lack of permanent organization and scientific staff.

This is the real work, work of the greatest national value to Australia and its citizens, and which is at present not provided for in any way. It demands the application of new knowledge to industry, thorough acquaintance with scientific methods of investigation, efficient supervision and direction of specialized research workers, organizing capacity, commercial experience, and intimate knowledge of industries and commercial methods of operation. It requires special men and special laboratories. To endeavour to carry it out as an addition to existing institutions would be a wasteful duplication of buildings and of staff, and a hopeless attempt to do exacting work in the spare time of busy men.

D. A.

EDITORIAL

MECHANICAL COTTON-PICKER.

Replies to recent inquiries made by the Institute of Science and Industry as to the development of a cotton-picking machine in the United States of America suggest the likelihood of its adoption in the not-distant future. Mr. Mark Sheldon, Australian Commissioner at New York, writing in February last, stated that he had been impressed with the general feeling that cotton-picking machinery was now passing through the developmental stage, just as harvesting machinery had done, and that ultimately a mechanical device would be perfected which would be found to work economically. Dr. N. A. Cobb, Agricultural Technologist to the United States of America Bureau of Plant Industry, who some years ago was Vegetable Pathologist to the New South Wales Department of Agriculture, has interested himself in this matter, and expresses the opinion that there is no doubt that machinery of this class is being improved and is becoming more practical. From time to time during the last ten years he has had the opportunity of seeing cotton-pickers in the field as well as demonstrated theoretically. At the present time, however, he advises that such machinery must still be regarded as more or less in the experimental stage. Cotton to be picked by machinery will have to be adapted to the machine in the method of culture, of growth, and also of variety. He thinks that Australian-grown cotton will probably be dirtier than American-grown, other things being equal, on account of the nature of the soil and climate in Australia giving rise to a greater amount of dirt and dust than is common in the cotton belt of America. One of the characteristics of machine-picked cotton thus far is that it contains more trash than good hand-picked cotton. It is unlikely that for a long time to come cotton-picking machines can be used advantageously on the highest-priced cottons, such as Sea Island, Egyptian, and other high-priced long-staple varieties. From recent developments, Dr. Cobb states, it would seem to him that if Australia attempts cotton-growing, it would be best to make a specialty of the higher grades. If this proved to be sound advice, he adds, cotton-picking machines would be of less importance than otherwise.

IMPROVEMENTS OF MECHANICAL DEVICE.

Mr. C. S. Nathan, of Perth, who is a member of the Executive of the Institute of Science and Industry, during a recent visit to the United States of America, also endeavoured to obtain first-hand information regarding the development and utilization of mechanical cotton-pickers. Statements with which he was furnished indicate that with the abundance of negro and Mexican labour in the United States, comparatively little attention has been given to the problem of picking

raw cotton by some sort of mechanical device. The Bureau of Plant Industry and the Department of Agriculture stated that: "Several devices of cotton-picking machines have been placed upon the market in recent years, but none of these have come into use, while a number of demonstrations of these machines have been made. The results of numerous efforts along these lines as yet afford very little ground for supposing that the problem is accessible to a mechanical solution along practicable lines. The successful cultivation of cotton is still dependent upon an ample supply of labour for picking the crop." In describing the kinds of machines which have been invented, the Bureau says: "Most of the machines are worked on the principle of the vacuum. The seed cotton is sucked from the bolls and carried through tubes into a receptacle in the rear of the machine. None of these machines have come into use." Nevertheless, manufacturers are devoting a great deal of money to the improvement of their machines. The Vacuum Cotton Picking Company, of Missouri, claim that the "Thurman" machine would pick all kinds of cotton, and pick it clean. The Dana Cotton Harvester Company, of Westbrook Main, notified that it had a machine which was at present being tried out in Georgia, Arizona, and shortly would be tried in South Carolina, and was meeting with good success. This company asserts that the harvester will pick cotton a number of times quicker than it can be picked by hand, and with much less physical exertion, as the machine picks the cotton and delivers it into a bag. By hand-picking the person has to straighten up and open the bag hung round his neck, and put his handful of cotton into the bag. This one feature of the machine would, therefore, enable the man to pick double the amount of cotton.

DIFFICULTIES OF MECHANICAL PICKING.

One of the principal difficulties which has to be overcome lies in the fact that cotton does not mature simultaneously. Even in the same field some bolls will be full, others being green, and still others entirely green. The machine, in its operation, does not discriminate, but picks every boll, acting, apparently, upon the theory that "all is fish that comes to its net." Another disadvantage at present is that the machine ruins the plants after picking, and thus prevents them from being picked a second time. The view taken by Dr. Cobb, however, is shared by most of the people who have directly interested themselves in the subject, and the proprietor of *Commerce and Finance*, a journal devoted in part to the cotton trade, writes that he hopes to have a machine ready within the next twelve months, but would give no information about it at present. It is highly probable that with a number of keen minds working on the problem, it may be possible to overcome the difficulties which now confront them, and produce a machine that will do the work of cotton-picking equal to that performed by that of hand-pickers.

LABOUR IN COTTON FIELDS.

Facts relating to the price of labour in cotton fields collected by Mr. Nathan are of interest. Wages in the picking section of the United States vary considerably. From the Bureau of Crop Estimates of the United States Department of Agriculture he found that early in the season (autumn of 1919) the range in price for picking 100 lbs. of

seed cotton varied from 1 dollar 6 cents in Alabama, where there was a short crop and plenty of labour, to 1 dollar 98 cents in Oklahoma. Prices in the same State often varied considerably, depending largely upon the supply of labour available and the urgency of the work. Frequently a cotton planter who was in a hurry to harvest his crop before winter would pay a higher price for the work than his neighbours who were not in such a hurry. At the close of November, 1919, cotton-pickers in the States of Texas and Oklahoma were receiving from 3 dollars to 3½ dollars for picking 100 lbs. of cotton seed. Weather conditions in these States early in the season kept pickers from the fields, and the farmers, realizing that wet weather in that section was approaching, willingly paid higher prices. It is customary in picking cotton to go over the field twice; some planters are said to give their fields a third and in some cases even a fourth picking, but usually two are sufficient.

AMOUNT OF COTTON PICKED.

It appears from the evidence obtained from various sources that a good hand will average from 200 lbs. to 300 lbs. of seed cotton a day, and some will pick as high as 500 lbs. during that time. The work is not especially arduous, and women and children as well as men engage in it; children are said to make especially good cotton-pickers, on account of their spryness. Along the States of the Mexican border, such as Texas, many Mexicans are employed. In the other States the work is done almost entirely by negro labour. Pickers work from "sun to sun." The season lasts, on the average, about 90 days, but in sections like the Mississippi Delta, where the average yield is heavy, it often lasts six months. Here, however, because the bolls are usually more or less rotten, the worker cannot pick as much late in the season as in the beginning. The skill is soon acquired. A picker will learn with slight practice to pick an entire boll with each hand. A man can rest himself while picking by crawling for a while on his knees; the sack which holds the cotton being attached to his shoulders and dragged behind. In fact, many pickers do two rows at a time, crawling on their knees between them and protecting their knees with cotton pads.

CATTLE TICK DIPS.

With the co-operation of the Governments of New South Wales and Queensland, the Institute of Science and Industry proposes to initiate at an early date investigations into cattle tick dips. Although the present official formula used in Queensland and New South Wales has proved to be efficient and generally satisfactory, it is considered possible that the same parasitical results might be maintained, and the ill-effects that sometimes occur obviated, by alteration of the composition of the agent. There is evidence that solutions containing a lower arsenical content than officially stipulated are effective in the hotter parts of Queensland. It is possible that it will be found that the strength of the parasiticide used may with safety be varied according to the time of the year and the climate of the locality where it is used. With a view to determining the limitations, a special committee has drawn up a programme of work to be carried out in the Burleigh

district, and similar experiments on a more limited scale will be afterwards arranged at Townsville and Bingleburra. The members of that committee are Messrs. G. E. Bunning (chairman) and C. J. Booker, representing the Institute; A. H. Cory (Chief Inspector of Stock) and J. C. Brunnich (Agricultural Chemist), representing Queensland; and F. B. Guthrie (Agricultural Chemist) and S. T. D. Symons (Chief Inspector of Stock), representing New South Wales.

WHITE ANT PEST.

A special committee appointed by the Institute to investigate the white ant problem has outlined a scheme of investigations. Before this is undertaken, Mr. G. F. Hill, entomologist, of the Institute of Tropical Medicine, who for some years studied and made considerable collections of termites in the Northern Territory, will be asked to prepare a monograph upon the subject. The committee points out that the inquiries will constitute a task of great magnitude and of far-reaching importance. The Government of New South Wales has undertaken to contribute to the cost of the work upon a £1 for £1 basis. The committee consists of Dr. G. P. Darnell-Smith, and Messrs. L. Harrison, B.A., B.Sc., E. E. Turner, B.A., M.Sc., A. A. Ramsay, and G. F. Hill.

POWER ALCOHOL.

In the February issue of *Science and Industry* there appeared an article by Mr. T. Baker, a member of the special committee appointed by the Institute to investigate the Production and Use of Power Alcohol in Australia, entitled "Power Alcohol." It is desired to point out that the views expressed by Mr. Baker do not necessarily represent the views of the other members of that special committee, and that the article expressed only the opinion of Mr. Baker. In this connexion, an extract from the Report on Power Alcohol (*Jour. Soc. Chem. Ind.*, July 15, 1919, p. 25 O.R.) will be of interest. "It is considered," states the report, "that the State should foster the production and utilization of alcohol for power purposes, because, as has already been indicated, the chief raw materials for its production are susceptible of great expansion, while the materials from which benzol, petrol, &c., are derived are limited to deposits, definite in extent, that cannot be renewed." Commenting upon that statement, the *Journal of the Society of Chemical Industry* (July 31, 1919, p. 264 R.) contained the following:—"The Report of the Inter-Departmental Committee on the Production and Utilization of Alcohol for Power and Traction Purposes marks a far-reaching and welcome advance in Government enterprise. Comparatively few of the public realize how important power alcohol will become in the future if rapid transport, whether by land, sea, or air, is to be developed to the extent which recent achievements have made probable. The known oil supplies of the world are estimated to last only a limited period, and even if productive new fields are discovered there still remains the need of providing alternative supplies of motor fuels derived from new raw materials. The fundamental fact that the vegetable raw materials from

which alcohol can be manufactured are being continually renewed and are capable of great expansion makes alcohol fuel the ideal for the future, and any State which neglects to encourage and to prepare for its application to these purposes is ignoring the best interests of its

RESEARCH WORK IN SHIPBUILDING.

The question of the advisability of "Lloyd's" arranging to undertake at its own expense experimental and research work in connexion with shipbuilding and marine engineering has for some time past received the careful consideration of the Committee of Lloyd's Register. In June, 1918, the Committee decided that such work should be undertaken by the Society, and appointed a special sub-committee on research. Amongst the subjects which this sub-committee has already had before it may be mentioned the carriage of fluid cargoes. Arrangements are being made for experiments to be carried out at the tank at the National Physical Laboratory for the purpose of obtaining information with regard to—(*a*) The effect of a fluid cargo in the form of oil in bulk on the behaviour of a ship in a seaway; and (*b*) the manner in which energy passes between the ship and the fluid in the holds.

NEW BRITISH STANDARD SPECIFICATIONS.

Four new specifications have been issued by the British Engineering Standards Association. They relate to—

(*a*) Instrument transformers, dealing with two classes of current transformers and one class of potential transformers.
(*b*) Indicating ammeters, voltmeters, wattmeters, frequency and power factor meters.
(*c*) Recording (graphic) ammeters, voltmeters, and wattmeters; and
(*d*) Rolled sections for magnet steel.

The last-named includes a symmetrical series of 60 sections for general purposes (26 of which it is recommended should not be used unless it is impossible to use any of the remaining 34 sections), and a supplementary list of ten special sections for ignition magnetos.

POLLUTION OF THE ATMOSPHERE.

The committee charged with the investigation of atmospheric pollution in Great Britain has published a report giving the results of observations at 24 selected stations. The condition of the atmosphere at Newcastle-on-Tyne and at Malvern is contrasted, these stations giving respectively the highest and lowest deposits of all the stations for which complete returns are available. At the former the mean monthly deposit of the solids contained in the atmosphere amounts to 20.81 metric tons per square kilometre, at the latter only 2.51 tons. Generally there is a tendency at all the stations for the amount of solid matter to increase during the summer. At that time of year dust raised by the wind forms the preponderating share; in the winter dust from fires preponderates.

SUBSTITUTES FOR LEATHER BELTING.

Owing to the shortage of raw materials necessary for manufacturing driving belts in 1916, the Belting Control Department of the Imperial Ministry of Economics was formed in Berlin to take over the control of the manufacture and use of driving belts. A great deal of valuable research work was carried out under the control of the Department, and much useful information hitherto unknown regarding the efficiency of substitutes for leather belting has recently been made available. The field of substitute can be generally divided into two parts:—

1. Belts manufactured on the principle of textile belting; that is, from woven flat webbing, strapping, or rope of hemp, paper, &c., with or without the use of interwoven wire.

2. Belts of the leather link type, manufactured from individual links of wire, wood, compressed paper, or sheet metal.

To the first class of belts we may reckon the cellulose belts and belts of mixed material. Cellulose belts are manufactured with thread made from sodium sulphite paper. The strength of these depends upon their form and method of construction. The main forms are: Folded (like cotton belts), built up from several separate ropes or tubes, woven and knitted belts, twine belts, and wire-armoured belts, mostly impregnated against the influence of moisture. Mixed material belts are in general differentiated from cellulose belts by the introduction of vegetable fibres or threads into their composition, either before or during the spinning process, or before they are woven into belting. Besides assuming the above-mentioned forms, these belts are also often plaited.

The most important of the second class are made of wood, compressed paper, or wire links. Belts composed of links of wood or compressed paper are manufactured by pressing together laminations of the material in the manner used in the Gall chain. In order to increase their strength, the individual laminations are frequently held together by means of metal clips, which, however, are arranged in such a way that only the wood or compressed paper comes into touch with the belt pulley. Belts of wire links are manufactured by placing side by side flattened wire coils, and fastening them together by means of bolts. In order to increase the adhesion of the belt to the pulley, paper twine is wrapped between the coils.

The idea that now the war is over there will be no need to use belts of substitute materials rests on a misunderstanding of the still existing difficulties of meeting the total demand for driving belts.

RESEARCH ON NON-METALLIC MINERALS.

In the *Engineering and Mining Journal*, New York, attention is drawn to the fact that in the past the non-metallic minerals have been considered as of minor importance in the mining industry. With the exception of such substances as phosphate rock, limestone, dolomite, and recently, magnesite, attention has been concentrated largely upon the metallic minerals. In recent times, we have seen the development of the alloy steels, with the resulting benefit to the structural engineer, and to manufacturers of high-speed engine and tool steels. Tungsten

in illumination, radium in medicine, Monel-metal where tensile strength and non-corrosive qualities are required, antimony in type metal and shrapnel lead, arsenic in agriculture, the copper-tin-lead-antimony alloys for anti-friction metal, alloys of nickel and chromium as resistant substances in electrical work, all have been developed by the persistent effort of experimental research, mostly during the last two decades. The utilization of products of non-metallic minerals has not kept pace with their associates in the mining field. This may be because the latter have offered a greater promise of success to the investigator. The American Institute of Mining and Metallurgical Engineers is giving attention to this matter, and, as a first step, has undertaken to collect and disseminate information amongst possible producers and consumers.

LOW-TEMPERATURE CARBONIZATION.

Speaking at a meeting of shareholders, the chairman of Low-temperature Carbonization Limited stated that a contract had now been arranged with an electric power company in Yorkshire to erect a plant and supply all the gas that could be made from the carbonization of 500 tons of coal per day. This gas is to be burnt in the power company's boilers in place of raw coal, and since the electric company in question is one of the foremost in the country and supplies its electric power at a very low rate, the Carbonization Company are offering to supply them with gas at a price which shows a great saving over coal.

Negotiations have been begun with an influential group of manufacturers situated in a great industrial district in Scotland, the object being to provide enormous quantities of power gas for burning under boilers in place of coal. Assurances have been given that consumers whose aggregate consumption is 4,000 to 5,000 tons of coal per week will purchase gas from a super-carbonizing station operated on the company's process as soon as erected.

Negotiations are also practically complete for the erection of a plant to carbonize a minimum of 500 tons of coal per day near Sheffield. —(Extract from *Engineering and Industrial Management*, v. 3 (1920), p. 11, January 1, 1920.)

National Physical Laboratory.

How British Industry Has Been Helped.

By W. M. HOLMES, M.A., B.Sc.

In the following article no attempt has been made to set out in detail all the advantages accruing to the nation from the establishment of the National Physical Laboratory in London, but rather to describe in broad outline the organization of research work which is carried out and to indicate in a general way the more important activities and their effect upon British industry and national well-being. Its splendid achievements during the war are now too well known to require further reference. That its scientific staff and equipment will continue to exert a strong influence upon the industrial progress of the nation is almost certain. Four years after the establishment of the Laboratory the *Deutsche Mechaniker Zeitung* issued the warning, "Our German instrument-making trade has every cause to watch carefully the development of the National Physical Laboratory and to take timely precautions before the advantages which it has already secured against English competition are too seriously reduced." Many branches of British industry now gratefully acknowledge the assistance which the National Physical Laboratory has been able to render. The writer's connexion with the Laboratory was limited to part of the war period, and to four months after the armistice. His impressions are based only on the experience gained during that time, and the story of the work of the various departments does not represent normal activities.

The history of the National Physical Laboratory up to 1919 is bound up with the work of the first Director, Sir Richard Glazebrook, who retired from that office on 18th September last, having reached the age limit of sixty-five. In an appreciation of his labours, Mr. F. E. Smith, in *National Physical Laboratory Review*, described the growth of the Institution:—"The establishment of a National Physical Laboratory was first suggested by Sir Oliver Lodge at the British Association meeting in 1891, at which time Sir Richard Glazebrook was Secretary of the B.A. Committee on Electrical Standards. Subsequently other prominent men drew attention to the need of such an Institution, and largely due to the strenuous advocacy of the Royal Society, the Laboratory was established in 1900. Sir Richard Glazebrook's great interest in standardization work and his wide outlook on physical science specially fitted him for the post of first Director.

Originally it was intended that the Laboratory should be developed at Richmond, but for various reasons the site in the Old Deer Park was abandoned, and the Government offered Bushy House, Teddington, for the purpose of a laboratory. Extensive alterations were undertaken, and in Bushy House provision was made for divisions of electricity, thermometry, metrology, chemistry, and metallurgy. Metrology occupied one small room in the cellars. Chemistry occupied the south-west wing (formerly the chapel) of Bushy House, and Metallurgy was

housed in the old kitchen, which was adapted for the purpose. The Engineering Department at this time occupied two bays of the present building with some outhouses, and Administration was housed in one room of Bushy House." . . . . "The development in the first four years was rapid, but the subsequent extensions were even more remarkable. The financial aid given by the Government was much too small for the Institution, which was really needed by the country, and the new buildings which were erected in rapid succession were, in many instances, furnished by private benefactors. In some cases the architects gave their services, the builders did their work at cost price, electric cables, &c., were presented free, and in general every firm who supplied any part of the equipment either gave all or part of the cost. In this way for eighteen years the late Director strove to build up a great national institution

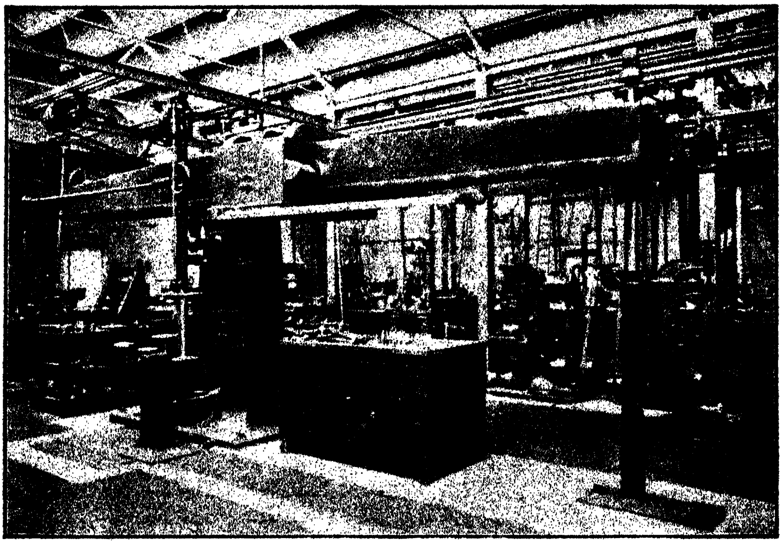
BUSHY HOUSE, FROM THE SOUTH.

such as he felt was needed by the industries of the country, and the great growth of the Laboratory up to the outbreak of war was almost entirely due to his initiative and untiring energy. Those who generously helped gave evidence of the confidence felt in the Director and the great work which he had undertaken. In 1909, when aeronautical research was favorably considered by the Government, Sir Richard was nominated Chairman of the Advisory Committee, and an aeronautical research laboratory was built at the National Physical Laboratory. It is largely due to the work done here that the position of the country in aeronautics is first in the world.

Sir Richard was on numerous committees, and during the war he acted as Adviser on Physics to the Ministry of Munitions. He received the C.B. in 1910, and in recognition of his services during the early of the war he was knighted in June, 1917."

From this modest beginning the Institution has increased in size, until now it consists of a large number of buildings, each specially equipped for some special purpose. Some departments are still located in Bushy House, but more extensive and more suitable accommodation is required. Recent additions are the aeronautics building, the gauge workshop, and the optics.

The Laboratory is now a part of the Department of Scientific and Industrial Research. The present Director is Dr. J. E. Petavel, F.R.S., who, prior to his appointment last September, was Professor of Engineering in Manchester University. His career has been brilliant, and he has done work of high scientific value in the borderland of physics, chemistry, and engineering. In 1914 he visited Australia in connexion with the meetings of the British Association for the Advancement of Science, and took part in the sessions of the engineering section.



BUCKTON TESTING MACHINE, ENGINEERING DEPARTMENT.

The Laboratory is divided into four main divisions, dealing with "Physics," "Engineering," "Metallurgy and Metallurgical Chemistry," and "The William Froude National Tank" respectively. Formerly the Director was superintendent of the Physics Department, having under him "principal assistants" over the various sections. Recently two of these have been made separate departments, each with its own superintendent. As originally founded, the Laboratory was managed by a committee appointed in accordance with certain Treasury regulations by the Royal Society. The staff were not civil servants, but employees of the Royal Society. The Treasury made a grant of £7,000 a year to the Royal Society towards the cost of the Laboratory, and in return exacted certain conditions in regard to the work to be undertaken and, among other things, in regard to the maximum salaries to be paid to members of the staff. For an institution of such value, a grant of £7,000 is obviously quite inadequate. A much

larger source of income was that earned by the Laboratory in the form of fees. Also certain technical institutions, like the Institute of Mechanical Engineers, Institute of Civil Engineers, Institute of Naval Architects have contributed to the Laboratory budget, in some cases by simple donations, but more frequently by grants in aid of some definite scheme of research.

The Royal Society, however, after this method of management had been followed for about seventeen years, felt that the difficulties were too great to permit of their carrying the financial responsibility any longer, and a change was decided upon, which came into operation during 1918, when the Laboratory was taken over by the Department of Scientific and Industrial Research.

In addition to the Director, superintendents, and principal assistants, there is a large scientific staff, graded as "senior assistants," "assistants," and "junior assistants," as well as a large staff of others, less highly trained, but often of very great value and experience, who are classed as "observers," while there is a further complement of skilled workmen.

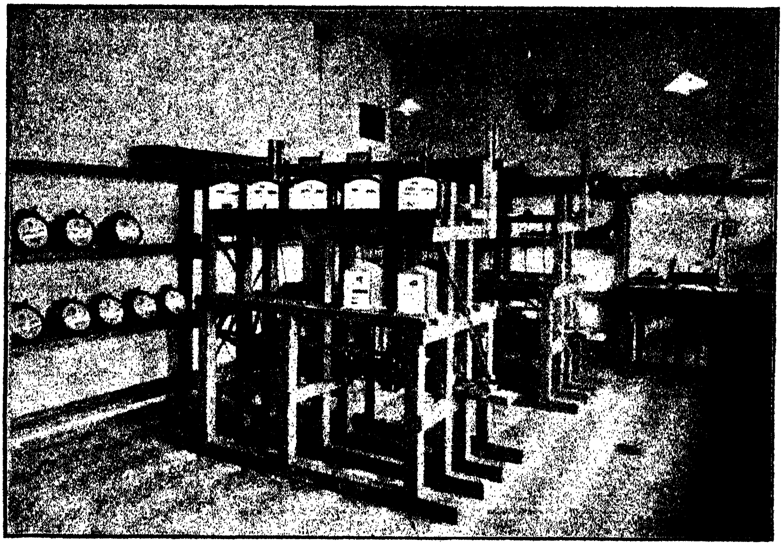
The work of the Laboratory may be discussed under two divisions. First, there are tests on apparatus submitted by manufacturers, Government departments, or any other persons or corporations. Secondly, there is research, which may be in the realm of "pure science" or, on the other hand, for the elucidation of problems arising out of industrial problems. The opportunities of conducting research vary from one department to another, but the ideal is that members of the scientific staff shall have opportunity for doing some research work.

In Bushy House is located the division which deals with electrical measurements of a fundamental kind. Here is installed the standard "ampere balance," by which the electro-magnetic attraction between standard coils carrying a current is accurately weighed. By means of this apparatus it is possible to determine the value of the ampere in "absolute measure." Besides this there is the Lorenz apparatus for the measurement of the unit of electrical resistance in absolute measure. This machine was designed by Mr. F. E. Smith, the superintendent of the Electricity Department, and constructed by the Engineering Department. In the hands of Mr. Smith it has yielded results whose accuracy is universally admitted. The calibration of standard resistances and of standard cells is undertaken by this department. For the former purpose the double bridge method is generally used. For many years Mr. Albert Campbell belonged to the staff, and he carried out numerous alternating current measurements. Among the many ingenious devices due to Mr. Campbell are the vibration galvanometer and the microphone hummer. Mr. Campbell resigned in 1919, and is succeeded by Mr. D. W. Dye, who had worked with him for some years. It would be interesting to tell of the most valuable war work done by this department, but in the absence of definite authority to do so, it is safer to be silent.

Another department, still housed partly in Bushy House, is Thermometry. This branch grew very rapidly in 1918 and 1919, owing to an enactment that all clinical thermometers offered for sale had to bear the National Physical Laboratory pass mark. During September, 1919, about 123,000 were tested, the fee being almost nominal. A

separate section deals with the important work of high temperature measurements. Here, the calibration of various forms of pyrometers is dealt with. The ordinary "bill of fare" in the way of commercial tests, includes radiation (Féry) pyrometers, optical pyrometers, and thermocouples. Important researches on the insulation of cold storage chambers have been conducted by Dr. Ezer Griffiths, the acting head of this section. It must suffice to pass with merely a mention other small sections, namely, Radium and X-Ray, Tide Prediction, and Chronometer Testing.

The section devoted to Optics is becoming increasingly important. It is housed in part of the administrative building. This section deals principally with the testing of optical instruments of all kinds, including nautical and surveying instruments, as well as telescopes, binoculars, periscopes, &c. Many original papers on the design of optical instruments, and on problems allied thereto, have been written by various



TAXIMETER ROOM.

members of the staff of this division. In the attempts being made to re-establish British optical industries, much will depend on the collaboration between manufacturers and the National Physical Laboratory. Important researches on the manufacture of optical glass are being conducted in the Department of Metallurgy and Metallurgical Chemistry, under the direction of Dr. Rosenhain.

The largest division of Physics—now a separate department—is Meteorology, of which the superintendent is Mr. J. E. Sears, jun. The work comprises measurements of length (including gauges of all sorts and descriptions), standardization of weights and barometers, the calibration of glass-measuring vessels, and the rating of watches and chronometers. During the war the subdivision dealing with length measurements was enormously enlarged, in order to carry out the calibration of a large proportion of the gauges required by the Ministry

of Munitions. This work had previously been done solely at the Woolwich Arsenal, and gauges had been supplied by a few outside firms, or were made in the arsenal itself. With the demand for munitions in quite unprecedented quantities, came the need for a corresponding production of gauges, with which the various shells, fuzes, &c., should be tested before acceptance by the Ministry of Munitions. Contracts for gauges were let to many firms, who had not tried that work before, any likely firms being used for this purpose. Quite a number of these, sooner or later, turned out good work, the most successful as a class being those who had had experience in the construction of internal combustion engines. In this matter, however, and in particular in the production of screw gauges, most valuable work was done by the staff of the National Physical Laboratory Meteorology Department, who collaborated with gauge-makers in the solution of their difficulties. This personal contact contributed largely to the success of various firms, who would certainly have become dispirited by early failures had red-tape measures been adopted. The great advantages offered to manufacturers of accurate machines, &c., is even now hardly realized by them, and it is to be hoped that the contact between manufacturers and the Laboratory will be maintained. Many special measuring machines were devised by members of the staff for the measurement of munition gauges, but there is not space at present to describe these. The arsenal branch of the Defence Department has acquired a set of the machines for the measurement of screw gauges.

One of the most important of these machines is a projection lantern capable of giving a picture 4 feet square without sensible distortion, the magnification being 50 diameters. This is most useful in the examination of screw gauges (for which purpose it was designed), but its usefulness extends over a far wider range, and it is applicable to many kinds of fine tool work.

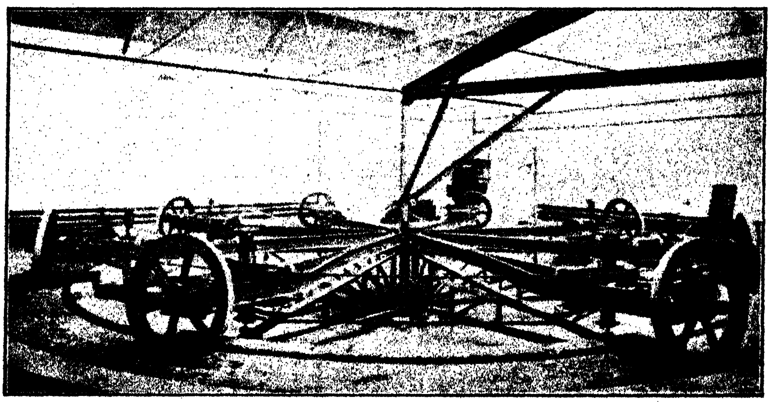
Important researches have been conducted on the subject of slip (Johansson) gauges, and a method of producing gauges of this kind has been elaborated. A new design of measuring machine, capable of comparing slip gauges to a high degree of accuracy, has also been designed.

The Electrotechnics division of the Department of Electricity (under Mr. F. E. Smith) undertakes tests on all kinds of electric machines, cables, and the like. The calibration of meters is an important part of its routine work. New methods of the measurement of power by electrostatic methods have been devised by members of the staff, and are in regular operation. The manufacture of manganin, hitherto a German monopoly, has been investigated by the staff of this division, and satisfactory processes have been devised. Photometry is also dealt with by this division.

The work of the Engineering Department comprises four main divisions, devoted, respectively, to the testing of materials, the testing and design of engineering apparatus, appliances, and machines, the testing and investigation of road materials and aeronautics. Limitations of space do not allow of more than the briefest description of the various activities coming under the above heads. Very valuable information has been obtained concerning

methods of testing materials, and several new machines have been designed for this purpose. Dr. Stanton's "Alternating stress" machine is one of these. In it the test piece is subjected alternately to compression and extension, and the failure of materials due to "fatigue" can be investigated thereby. Three impact-testing machines—the largest of which is sufficiently powerful to break a full-sized railway coupling at one blow—belong to the equipment. Recently, experiments on the relative values of different lubricating oils have been carried out, using a special machine, in which the efficiency of a worm gear, when lubricated with the oils under test, is measured under different conditions of load.

The Aeronautics division, though attached to the Engineering Department, is separately subsidized by the Government, and is used as the official laboratory of the Advisory Committee on aeronautics. New premises have recently been built and equipped. The method most generally adopted for the investigation of aerodynamic problems is to test scale models of aircraft (or parts thereof) in wind-channels. In these the model is supported on a special weighing machine (by which the forces and moments acting on it can be measured), and a stream



ROAD TESTING MACHINE.

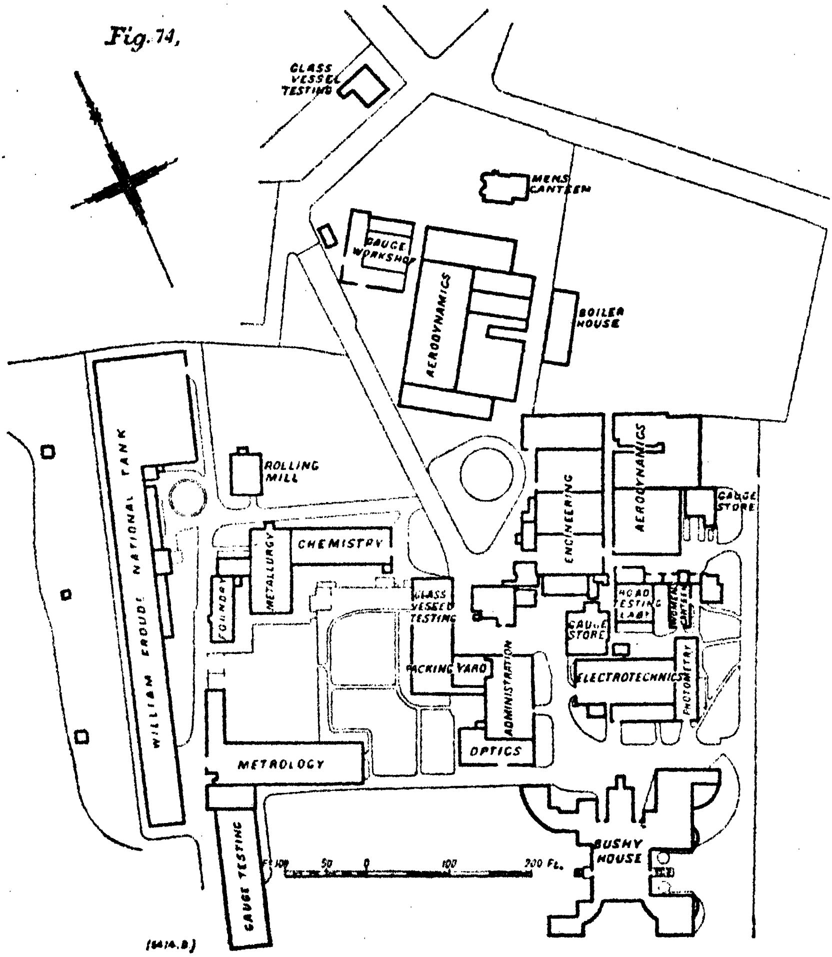
of air blown past it through the channel. The smallest of the channels is 4 feet square. There are two or three 7-ft. channels, and a new channel 7 feet by 14 feet in section has just been completed. Many of the staff are very expert mathematicians, and have ample scope for the employment of their special knowledge in direction.

The Metallurgy Department is under the superintendence of Dr. W. Rosenhain, a native of Melbourne, and a graduate of its University. His interests lie chiefly in the study of the Physics of Metals, which term may be used to include Metallography and the whole subject of the thermal and mechanical treatment of metals and alloys. From a study of the crystalline structure of metals, most extensive and valuable information has been obtained. For example, the microscope has often revealed causes of failure in metal parts, when the testing machine, by itself, has given but little indication of the trouble. Among the equipment of this part of the Metallurgy Department are special metallographic microscopes, and special electric furnaces for investigating the

cooling curves of metals. In these furnaces the specimen can be heated or cooled at any convenient rate by regulating its speed of travel through the furnace, the temperatures at various parts of the furnace being steady, but varying from point to point.

Researches on light alloys have been carried out, the tests lasting over some years. The behaviour of these alloys under different conditions of temperature, heat treatment, or mechanical treatment has

Fig. 74.



GROUND PLAN OF THE NATIONAL PHYSICAL LABORATORY.

been investigated, and in this connexion most valuable information has been obtained from the use of the experimental rolling mill. Other sections devoted to the chemistry of aeronautical materials and to general chemical analysis must be passed over with a mention.

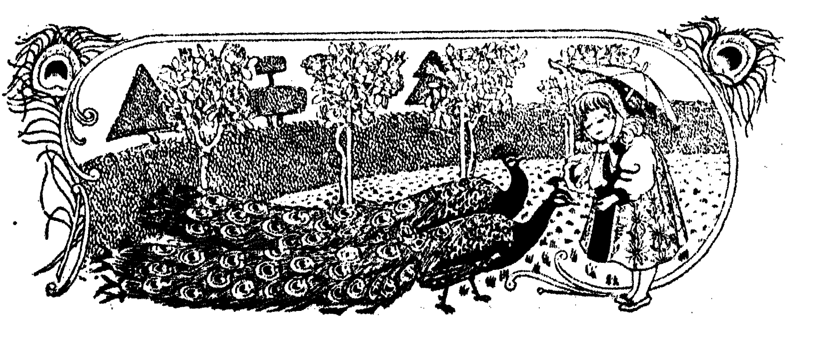
Another section is devoted to research on optical glass. Not only is it sought to arrive at the correct composition of glasses of various optical properties, but the problems of actual manufacture on a large

scale are being dealt with. The design of economical furnaces, the selection and preparation of suitable refractories, are but two of the lines along which this research has been directed.

The last of the departments of the Laboratory is the William Froude National Tank. This consists of a basin 500 feet long, 30 feet wide, and 12 feet 6 inches deep in the middle. It is spanned by a travelling platform or carriage, which runs on accurately levelled rails, being propelled by four powerful motors. By means of these, the carriage can be brought up to any required speed (up to about 20 miles an hour) quite rapidly, and the desired speed maintained for quite a large portion of the travel of the carriage. The carriage tows a scale model of the ship whose design is under test, and from the resistance to towing at various speeds, which is measured by dynamometers on the carriage, information as to the performance of the full-sized ship can be obtained. The model is towed at much lower speeds than those at which the ship will be driven, the relations between speeds, resistances, and linear dimensions being known by the application of the principles of dynamic similarity. Quite recently the lines of a tramp steamer were investigated, and from the results of tests on the model improvements were suggested which resulted in a reduction of 35 per cent. in the horsepower required to drive the steamer.

Very large use was made of the tank during the war, but of this it is wiser to say too little than too much. However, we may quote a statement that has been published, to the effect that Sir Alfred Yarrow credited the staff of the tank with having drawn out the lines of the world's fastest destroyer.

Acknowledgments are made to Dr. Rosenhain for extracts from his lecture before the West of Scotland Iron and Steel Institute; for plan of National Physical Laboratory to National Physical Laboratory circular letter; and for photos. to National Physical Laboratory staff.



Milk and its Products.

By EWEN MACKINNON, B.A., B.Sc.

Milk is the only substance that has any claim to be called a complete food. For many months in early childhood it is the only food provided by nature; and also in many cases of adult life, and in sickness, it is often called upon to sustain life for long periods when no other food is allowed. How much does the average person know about milk, or how much care is taken to provide for a sufficient supply of this valuable food in a fresh, pure condition, or to keep it in such a state? To most people, it is only a white, opaque liquid which, on standing, gradually turns sour and thickens, while a layer of cream collects on the surface. In addition to this, it is well known as the source of butter and cheese.

Does the average person know why a quart of milk is more valuable as a food than ¾ lb. of lean meat; or why gelatine, that was once considered such an excellent food, is now classed as an incomplete food? These are questions on dietetics that are constantly occurring in public, as, for example, in the present investigations into the living wage and the food requirements of an average family. It is proposed, however, to show here what are the various products derived from milk, and how they are prepared. All these substances are either being made in Australia, or can be made here; and, as our conditions are favorable for the supply of good, clean milk, it is hoped that there will be an increasing demand for such Australian-made goods. No doubt, the general public will need some education as to the value of cheese, milk powder, and butter-milk powder, the uses of casein and milk sugar, and the preparation of artificial foods, &c. This will be brought about by the sympathetic attitude of the present-day adult towards the teachings of science, and the extension of higher education in the direction of physiology, hygiene, and domestic economy to the rising generation.

Cow's milk is used by us for our fresh supply and for all prepared products; but with some races, it is the milk of other animals that is used, *e.g.*, mares, asses, goats, camels, sheep, and reindeer. The essential elements necessary to support life are contained in the milk of all these, but the relative proportions vary. Each mammal produces milk of a composition peculiarly suited to its own offspring. Consequently, human milk differs from cow's milk chiefly in the greater quantity of sugar, and in the less proportion of protein, which is not so readily coagulated by acids as cow's milk is. Hence, cow's milk often needs some modification for feeding infants.

The chemical nature of milk is better known than its physical constitution. The chief constituents of cow's milk of average quality may be stated as follows:—

1. Water		87·2 per cent.
2. Fats		3·7 per cent.
3. Proteins (total)	3·6 per cent.	
(a) Caseinogen 3 per cent.		
(b) Lactalbumin, ·5 per cent.		9·1 per cent.
4. Milk sugar	4·8 per cent.	
5. Mineral matter	·7 per cent.	
Total		100·0 per cent.

Another way of stating this is: Total solids, 12·8 per cent., of which the non-fatty solids form 9·1 per cent., and the fat 3·7 per cent. of the total weight of the milk.

The fat is present in milk in the form of an emulsion, but not a perfect one, as, on standing, it rises on account of its lower specific gravity (·92), and forms the cream layer. It is also readily separated by the centrifugal action of the separator, and its physical condition is altered. It is thought that each droplet is surrounded by a membrane, in which are distributed minute particles of the chief protein of milk, viz., caseinogen. This is present in colloidal suspension, and acts the part of stabilizer in the system of water (the dispersing agent), oil drops, and proteins. The other protein, lactalbumin, is sometimes known as whey protein. It is not precipitated by acids along with casein, and it is not coagulated by rennin. Caseinogen is a complex phosphoprotein, combined with a calcium salt, and is readily precipitated by acids or salts. It then forms the insoluble casein or acid curd. The curd formed by rennin is slightly different in composition, and is a sweet curd—paracasein—which will not form in the absence of a soluble calcium salt. In cheese manufacture, the paracasein usually encloses most of the fat with it, so that there is a wide difference between the whey of the cheese vat and the buttermilk after butter making. On this account, 97 per cent. of butter consists of fat (83 per cent.) and water (13 per cent.), whereas fresh cheese consists of water, fat, and proteins (total 94 per cent.), in the ratio of 37 : 33 : 23 per cent. respectively. The sugar present is lactose or milk sugar, and unlike the proteins, it is in true solution. Hence, after the various operations of butter or cheesemaking, or casein manufacture, it is still in solution, and can be recovered. When milk is kept for some hours, the lactose becomes converted chiefly to lactic acid by the fermentation action of lactic or other bacilli. When the percentage of acid produced reaches about 0·8, the milk "sours," and casein is precipitated by the lactic acid. By the fermentation of lactose in whey, lactic acid may be produced.

Every 6 lbs. of butter-fat by the Babcock test will yield about 7 lbs. of manufactured butter. The difference between the two is known as the overrun, and usually goes to the credit of the factory. In cheese manufacture, suppliers are generally paid on the fat test also, as there is a parallelism in the variation of fat and protein; milks with high

fat percentage are also high in protein, and each pound of fat by test is equivalent to a yield of 2·6 lbs. of cheese; or 100 lbs. of milk of 3·8 per cent. fat will make about 10 lbs. of cheese.

Homogenized milk is milk heated to a temperature of 50° to 60° C., and then forced under great pressure through very small orifices, thus reducing the fat particles to about 1-100 of their original diameter. Such a milk, when allowed to stand, will not give a layer of cream on the surface. It is now a perfect emulsion, the fat being in colloidal suspension. Homogenized cream is very viscous. It can neither be churned nor whipped. It is utilized in making ice cream, as a cream containing 17 per cent. fat will, if homogenized, serve as effectively as ordinary cream of 25 per cent. fat. To overcome the impossibility of whipping, ½ per cent. of gelatine (or gum tragacanth) is added. These also produce a harder and smoother cream, with higher melting points and greater digestibility.

Omitting the supply of fresh milk and cream, we may summarize the various products of milk as follows:—Butter, cheese, and casein; condensed milks—concentrated or evaporated, either from whole or skimmed milk, and either sweetened or unsweetened; powdered milk (desiccated or dried), from whole or skimmed milk; powdered butter-milk; lactose; lactalbumin; lactic acid.

We shall omit the processes of butter and cheese making, which are generally known, and refer to the other products mentioned.

Casein.—This is readily manufactured from either skim milk or butter-milk by several methods, *e.g.*, rennet method, sulphuric acid method, and combined lactic and sulphuric acid process. The first is largely adopted in France, which supplies the best casein on the English market, where the demand is about 1,000 tons per annum. This casein is in great demand in Germany for making imitation celluloid (galalith) for buttons, combs, toys, knife-handles, &c. Lactic acid casein was not found suitable for this purpose. With rennin, the caseinogen is changed into a paracasein in the presence of soluble calcium salts. The change is wholly dependent on the action of an enzyme. Owing to the greater solubility of lactic acid casein, this variety is manufactured for making paints and glues, and for surfacing paper (this absorbs 85 per cent. of lactic casein output). About 2 gallons of rennet (costing about £3 15s. now) are required to produce a ton of casein. Sweet milk is used, and after heating it to a temperature of 97° to 100° F., 4 ozs. of rennet are added for each 100 gallons of milk.

Coagulation takes place in about 30 minutes. The curd is cut up fine and stirred well, as in making cheese. It is then slowly heated to about 130° F., which should take about 30 minutes. The curd is well washed in water at 140° F. It is dried at a lower temperature than acid casein (130° F.) not later than next day.

The sulphuric method is largely used in United States of America. It has the advantage of enabling the work to be finished in one day, soon after separation. The milk is heated to 120° F., and commercial sulphuric acid (sp. gr. 1·83) is used at the rate of 1 pint to 100 gallons of milk. Before adding the acid, it is diluted with 1 gallon of water to each pint of acid. The diluted acid is added to the milk, stirring

gently all the time. Too much acid produces a fine-grained curd, which is difficult to drain and handle. The whey is next run off, and the curd washed well in cold water; then drained and pressed. If a tough, hard curd is required, it is covered with water and heated to 175° F.

In the lactic and sulphuric process, the skim milk is heated to 98° F., and 10 per cent. of starter is added. In about six hours, the acidity will reach ·75, and the milk coagulates. The curd is cut, and steam heated to 120° F., and the whey is then run off. The curd is washed in boiling water and drained. It is next dissolved in a washing soda solution, using 3 lbs. of soda to each 100 gallons of milk, and an amount of water equal to one-third of the volume of milk. The mixture is then heated to 140° to 150° F., and the curd dissolves. The temperature is reduced a little, and the casein is precipitated by H_2SO_4 used as in the sulphuric method. The curd is thoroughly washed in water, drained, and pressed.

Edible Casein.—This is made to provide an edible casein for the manufacture of the numerous patent foods. Sweet skimmed milk is heated to 85° F., and hydrochloric acid at the rate of 1 oz. to each gallon of milk is used, diluting it with two and a half times as much water. After running off the whey, the curd is washed at 110° F., and again at 140° F., and then in boiling water. After draining and pressing, it should be light-yellow in colour, and free from taste and smell. The moisture content should not be more than 12 per cent., and the casein when ground and mixed with 1½ per cent. by weight of anhydrous sodium carbonate, should be readily dissolved in water.

To render curd fat free and white in colour, the precipitated curd, after well washing and pressing, is sometimes stirred to a pulp with half its weight of water, and then steamed for 25 to 30 minutes in a wooden vat, with about one and a half times its weight of a 1 per cent. solution of soda. This removes the lactic acid and butter-fat. After heating, the mass forms a thin milky fluid, which is transferred to a separate vessel to cool, and precipitated with nitric acid. One hundred parts of curd yield 40 parts of purified casein.

Whatever process is used in manufacturing, the casein should be dried in an oven with carefully regulated temperature (120° to 140° F.). The cost of manufacture will vary very much when full account is taken of all costs (wages, fuel, depreciation, raw material, acids, rennet, packing, &c.). At the present time, these are continually changing, so that any estimate made may not be reliable for long. Best French casein was selling at £110 a ton nine months ago. Technical casein is now selling at £80 to £83 a ton; and casein for making paints, at £75 to £80 a ton. Only the best quality will find a good market, as large stocks are held in England and the United States of America; and France, even with her depleted herds, is able to supply most requirements. It is expected, however, that there will be an increasing demand, and Australia is finding a market in the East. The world's demand for casein at present is 20,000,000 lbs. annually; and in 1918, United States of America produced nearly 9,000,000 lbs. In 1910, United States of America imported 3,800,000 lbs. In 1917, New Zealand exported

575,000 lbs., valued at £12,564. The commercial value of casein depends on its solubility, adhesiveness, and swelling capacity. In Europe, this is tested by heating 20 gms. of casein in 120 c.c. of water with 3 gms. of borax. In five hours, the casein should be in solution. Another test is to heat 10 gms. of casein in 50 c.c. of water with 2 c.c. of 33 per cent. ammonia for two hours, at 140° F. The casein should then be in complete solution.

Among other methods of preparing industrial casein, the following may be mentioned:—

(1) Casein is precipitated by leading SO_2 gas into milk warmed to 50° to 70° C. The process is complete in a few minutes, the time taken being so short that there is no danger of inversion occurring. (German Patent 184,300.)

(2) A fat-free casein is obtained by mixing skimmed milk with alkali, warming, removing fat by centrifuging, and then precipitating casein in the ordinary way with acid. (German Patent 135,745.)

(3) The Bureau of Animal Industry, United States of America, has recently developed two good methods—(*a*) the "ejector" method, using natural souring; and (*b*) the grain curd method, using hydrochloric acid, producing a casein of exceptional purity. At the beginning of this year, only one large creamery had put it into operation. In (*a*) skim milk is soured until the acidity (using standard alkali and phenolphthalein) reaches ·8 to ·9 per cent. expressed as lactic acid. It is then allowed to run out of a tank through an ejector, where it is rapidly heated by introducing steam, and to fall into a second tank, where the curd collects on top of the whey. In (*b*) the method takes its name from the character of the curd when obtained from the milk, in which the hydrogen ion concentration is approximately that of the isoelectric point of casein $P_H = 4{\cdot}6$. This is determined by testing with methyl red small samples against stock solutions of known hydrogen ion concentration. By the careful regulation of acidity and temperature, the curd is easily freed from impurities.

The uses of casein are already numerous and varied, and are continually extending. Omitting its use in cheese-making, for which casein is not separately prepared, the following are some of the commercial uses of the prepared product:—

1. For administering medicinal agents, *e.g.*, salicylates, alkaloids, lithium, mercury, silver, iron, bismuth, and others.

2. As a mucilage, in adhesives and glues, in putties and cements.

The ash and water content of casein vary according to the method of manufacture. A determination of the ash makes it possible to use casein made by any method, and still obtain uniform results in making water-resistant glues. The equation $W = {\cdot}24 \text{ Ash} + (1{\cdot}85)^2$ gives the ratio of the weight of water to be used

compared with the total weight of casein used ($W = \frac{\text{Water}}{\text{Casein}}$ or water casein ratio) to produce glues of standard medium viscosity, *e.g.*—

Type of Casein.	Ash per cent.	Water/Casein.
Grain curd	1·8 ..	2·3
Lactic acid	2·5 ..	2·4
Mineral acid	4·0 ..	2·8
Rennet	8·6 ..	3·9

The variation in water requirements is of most importance in making glues, and casein dissolved in alkali and combined with lime forms a water-resisting glue which has been of great value in the construction of aeroplanes. Such glues are now available commercially.

3. As a medium for mixing colours in textile printing. As a dressing for linen and cotton fabrics, and for sizing and loading textile fibres.

4. For waterproofing coloured, art, and drawing papers, cartridge cases, textile fibres to be worn next to the skin, and cardboards. Mixed with asbestos it forms a waterproof and fireproof material.

5. In making various paints, washes, and enamels. These can be made suitable for use on any kind of surface—wood, brick, stone, cement, iron, &c. With silicates, it forms a cheap fireproofing and waterproofing paint, and can be used with advantage on damp walls.

6. In the preparation of various plastic masses in imitation of ivory, celluloid, bone, horn, and leather. Galalith is a well-known substitute in which the casein is hardened with formalin.

7. In the preparation of many patent foods, *e.g.*, Sanatogen (approximately 95 per cent. casein and 5 per cent. sodium glycerophosphate); Visem, a casein food containing lecithin and salts of glycero-phosphoric acid; Plasmon, 75 to 80 per cent. protein, 5 to 10 per cent. fat and milk sugar, and 5 per cent. sodium carbonate—very assimilable, and useful as a diabetic food. Others are eucasein, nutrose, sanose, Vi-casein, and eulactol.

8. For fining wine, being cheaper and better than albumin.

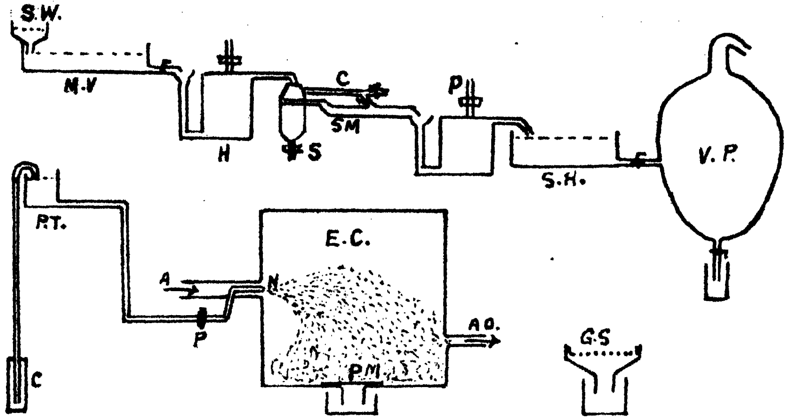
9. Miscellaneous uses, such as solidifying mineral oils, for paint removers, sealing for bottles, shoe polishes, roofing pulp, and in ointments and soap.

There are six or eight factories manufacturing casein in Victoria, chiefly in the southern parts—at Camperdown, Colac, and near by; and two firms in New South Wales, one being in the North Coast dairying district. Although skim milk is used, the casein prepared is not very free from fat, no guarantee of less than ½ per cent. being given.

Condensed Milk.—The manufacture of condensed milk is now a well-established industry in Australia, and there are many factories, making practically all the kinds of sweetened and unsweetened milks. A historical account is given by Mr. O'Callaghan in his book on "Dairying."

It has to be borne in mind that sweetened condensed milk is not sterile, but that bacterial growth is kept in check by the high per cent. of sugar and the lack of moisture in the highly concentrated medium. It is rather a too-common occurrence to open a tin in which bacterial growth has injuriously affected the contents. In the concentrated milks it has been found necessary to add boric acid as a preservative in our warm climate. The unsweetened milk, however, is sterile. To make it so it has to be raised to a much higher temperature.

In making sweetened condensed milk, fresh milk, partly or wholly skimmed, is heated to near boiling, and 16 lbs. of sugar are added for each 100 lbs. of milk, and the mixture condensed in vacuo at 130-150° F. until the ratio of $2\frac{1}{2}:1$ is reached (*i.e.*, $2\frac{1}{2}$ volumes of fresh milk are



SCHEME TO ILLUSTRATE THE SPRAY METHOD OF DRYING MILK. (*After Delépine.*

S.W. Automatic Weigher and Strainer. M.V. Mixing Vat. H. Heater. S. Separator. C. Cream, removed if drying skim milk, otherwise may not separate. P. Pasteurizer. S.H. Steam-heated concentrating pan. V.P. Vacuum Pan. From V.P milk drawn into metal cylinders (2nd row C), from which it is pumped to P.T., Pressure Tank, then by P., Force Pump, along with A., Hot Air, into Tin-lined Tank or Evaporation Chamber, E.C. Vapour removed at A.O. or may go through 2nd chamber. P.M. Milk Powder removed from floor-trap, and sifted through fine gauze screen, G.S. N. Nozzle.

condensed to 1 vol.). The finished product contains 40 per cent. sugar, and its specific gravity is 1·29. It is not sterile.

If whole milk is to be condensed, it is more usual to separate the cream and add it later to the condensed skim milk. The cream should be pasteurized. Condensed and powdered whole milks tend to become rancid, and there is also some change in the physical condition on standing. The fat may be prevented from rising by homogenizing the milk.

In the preparation of condensed milks, the temperatures must be kept as low as possible, to prevent charring of the sugar and so darkening the colour of the finished milk. Hence the use of concentration in vacuo. This means the use of special machinery, thus adding to the cost of the finished product.

In the preparation of *dried milk powders* there are many systems in use, such as the Ekenberg, the Just (= Hatmaker in Europe), the Campbell, the Passburg, the Merrell-Soule (original Stauf patent in Germany in 1901), the Dick, and the Grey-Jensen. Most of these

systems employ practically one of two methods, viz.:—(1) Delivering the milk in a very thin sheet over the surface of a revolving heated roller. The size of these and the temperature used are sufficient to dry the milk before one revolution is complete, and the dried powder is scraped off the roller and finely ground. The Passburg system combines a preliminary concentration in a vacuum pan, followed by spreading on a roller. (2) Spraying the milk through a fine nozzle into a heated chamber, with some provision for removing the moisture, *e.g.*, by using a current of air. In the Campbell system a drying warm air is blown through the milk until it becomes thick. The milk is then exposed to the hot air by being dropped through it on to heated drums, where it is ground to fine powder.

The Merrell-Soule process was introduced into America in 1905, by the purchase of the German patent (1901) of Robert Stauf. This was the first of the spray processes, and the claim of the patent is as follows:—"The process of obtaining the solid constituents of milk in the form of powder, by converting the liquid into a fine spray, bringing such spray or atomized liquid into a regulated current of heated air, so that the liquid constituents are completely vaporized, conveying the dry powder into a suitable collecting space away from the air current and discharging the air, a vapour, separately from the dry powder." The Merrell-Soule Company patented in 1907 the further economical step of combining a preliminary condensing in a vacuum pan.

This process is adaptable to drying a great variety of milk products. One of the great difficulties that had to be overcome was the development of rancidity; now the powders will keep well for six months to a year, and even milks up to 18 per cent. cream are successfully dried. There are many powders on the market, however, that do not keep well, and as the public generally does not discriminate as to the process, or even the brand, the whole industry suffers. Trufoods Ltd. have purchased the sole rights of the Merrell-Soule process for Australia, and also control the sale of milk powders in England. The Merrell-Soule system, however, is not the only one using the spray method. There are many others which differ chiefly in the nature of the nozzles used, the nature of the chamber, and the manner of removing moisture and collecting the products.

Buttermilk, which either went to waste or was fed to pigs and calves previously, is now successfully dried to a powder. Apparently Victoria has led the way in this matter, though in most work in connexion with the preparation of milk powders, condensed milk, and the pasteurization of cream, New Zealand has been in the van. Buttermilk powder can be used to advantage by confectioners, bakers, and pastrycooks. It contains a high percentage of lactic acid, and a considerable amount of butter fat. Both of these add to its value in baking. The milk powder prepared by the spray system has been realizing 10d. a lb. in the United States of America, while the powder from the heated rollers was being sold at 7d.

The rapidity with which the evaporation takes place in the spray method apparently is most advantageous. In accordance with physical laws the evaporation of a liquid uses up heat, and the milk solids are

probably kept in a cooler condition until they are dry. In ordinary condensation of milk, if the concentration be carried beyond certain limits there is an injury to the solids. There appears to be a critical stage somewhere between high concentration and dryness where prolonged heating does much damage. In the spray process this stage is passed through almost instantaneously, and after the dry condition is reached, much higher temperatures for a short time will do little harm. Further, the powder prepared by the spray process retains the properties of the constituents better, as on the addition of water the original milk condition is practically restored. There is no sediment, the casein is colloidal, the fat is in globular emulsified form, and the albumen is not coagulated. In addition the enzymes are still active. Whether the activity of vitamines has been tested is unknown to the writer.

There is a fertile field for research in the preparation of dried milks, condensed milks, and other "tinned" milk products, as well as a need for much educational work to remove many prejudices against the use of such products. The greatest objection has always been the uncertainty of the quality of even the best brands on the market. For years past the writer has been engaged in the bacteriological examination of all kinds of dairy products, having frequently to follow out to the factory the cause of blown and tainted tins of cheese, milk, and other products, and is thoroughly convinced of the need of greater supervision of all places that prepare such foods, and the great need for some instruction in bacteriology for those controlling such work. There can be no doubt that a well-prepared condensed milk or a milk powder is to be preferred to a bad fresh (sic!) milk supply. This applies particularly to some parts of Melbourne, where it is not possible to obtain fresh milk even once a day, but only "bulk" milk many hours old, and near the point of coagulation. Boiling cannot be relied upon to convert a bad milk into one fit for food for children. Consequently one has to rely on some such system as the Talbot bottle, which means double the cost for milk, or to resort to condensed milk or milk powders, which, owing to the great demand, the enormously increased export trade, drought conditions for several years past, &c., have also increased greatly in price. The milk supply of our great cities needs the investigation and control such as exists in Boston, Washington and New York, or Manchester in England.

In England, milk powder is being sold at 1s. 2d. a lb. at the factory door. In Melbourne, the retail shop price of powdered milk locally manufactured (spray method) is 1s. 8d. a lb. The Australian price is double the American, and 40 per cent. above the English. Even at that price it is slightly cheaper than whole, fresh milk, and much purer. One pound of powder makes 8 lbs. of restored milk (without fat), or about 6½ pints. The same quantity of fresh whole milk, at 7½d. a quart, would cost 2s., *i.e.*, a saving of 4d. by buying powder, but at the loss of the cream.

Ten million pounds were imported in 1918 into England, and 1,122,000 lbs. were manufactured, a total of over 11,000,000 lbs., equivalent to ·27 per head of population. In New York, as much as

12s. 6d. per 100 lbs. is paid for milk containing 3 per cent. fat, and an additional 2d. for each tenth of a pound of butter-fat above 3 per cent. One hundred pounds of milk yield from 8 to 9 lbs. of milk powder. The total production in United States of America, in 1918, was 25,626,000 lbs., and 18,000,000 lbs. were used, equal to ·16 lbs. per head of population. In Australia, the total production of condensed milk and milk powder (Statistics combine these) was as follows:—

1911	23,120,000 lbs.
1913	32,000,000 lbs.
1914	32,000,000 lbs.
1915	27,000,000 lbs.
1916	46,000,000 lbs.
1917	56,200,000 lbs.

Consumption (Commonwealth)—

Condensed milk and milk powder—

1916	£1,067,000
1917	£1,422,700
Fresh milk—	
1916	£3,088,000
1917	£4,566,000

In 1918 there were five dried milk factories in New Zealand and one condensed milk factory in operation. Her exports were 36,640 cwt. of condensed and dried milk, valued at £153,538.

Dried Milk Exports (1918) *to England.*

United States of America ..	61,000 cwt.
Netherlands	20,000 cwt.
Canada	6,000 cwt.
Victoria	600 cwt.

Other countries together, in 1914, sent 11,560 cwt.; but none during the war.

In 1918, the United Kingdom imported 5,600,000 lbs. of milk under such names as humanized, peptonized, and sterilized. This milk was used principally as invalids' and infants' foods.

New Zealand exported 38,000 cwt. (Glaxo).

United States of America exported 6,200 cwt.

Australia exported 3,832 cwt.

The cost of manufacturing milk powder in United States of America is approximately 3½d. per lb. London quotations for milk powders about six months ago were:—Netherlands, 115s. cwt. (made on hot rollers); other brands soluble in hot water, up to 129s.; soluble in cold water, 150s. From our statistics, it would appear that approximately one quarter of the total milk consumed in Australia is in the form of condensed milk and milk powder.

Milk Sugar.—The sugar present in milk is known as lactose. It has poor sweetening power compared with cane sugar. The extraction of it from skim milk, butter-milk, &c., requires some considerable capital to be invested in plant, and unless there is a large available supply of raw material, and a more extended market, it will hardly pay to extract it. It is considered that it costs 6d. a lb. to prepare. The demand has been unusual during the war, as much of it was required for making smoke shells. Britain requires 500 tons per annum. There appears to be a little market for the substance, small quantities being used in medicine. Stocks now held are probably sufficient for the supply of the world's demand. It is better economy to divert the sugar to some other purpose, such as hog food. It is sometimes used in brewing, as it is not fermented by ordinary yeast, and so remains in the finished product as unchanged carbohydrate, thereby increasing the "extract" of the beer.

Lactic Acid.—Lactic acid can be prepared by the fermentation of the milk sugar or lactose. As lactic acid exists in several varieties, the form that will be produced will depend on the nature of the bacteria employed. Pure cultures of "starter" bacteria will generally produce the dextro-rotating variety. After the removal of butter-fat and caseinogen, the whey is allowed to ferment at 70° to 80° F. The liquor is then evaporated to one-third of its bulk, decanted or filtered, and saturated with milk of lime. This converts the lactic acid to calcium lactate, which remains in solution, while calcium phosphate is deposited. This is filtered, and calcium is precipitated with oxalic acid, forming calcium oxalate, setting free lactic acid. By a third filtration, a solution of lactic acid is left, which is concentrated to syrupy consistency and treated with alcohol, which dissolves lactic acid and precipitates lactose and salts. Filter and distil off the alcohol, leaving the lactic acid. Of the salts of lactic acid, the antimony lactate is used to an increasing extent as a substitute for tartar emetic in dyeing and calico printing, and other salts are used in dyeing leather and wool. The acid is largely used in tanning for removing the lime from the skin.

AVERAGE COMPOSITION OF MILK PRODUCTS.

—	Fresh Milk.	Separated Milk.	Cream.		Butter—Fresh, Salted, and Washed, from Ripened Cream.	Butter Milk.	Cheese, Fresh Cheddar.	Whey, from Cheese Vat.
			Thin.	Thick.				
Water	87·2	90·5	64·0	39·4	13·8	91·6	37·3	93·0
Fat ..	3·7	·3	29·3	56·1	83·0	·5	33·4	·3
Protein	3·6	3·1	2·8	1·6	·8	3·3	23·4	·9
Sugar	4·8	4·8	3·5	2·3	·4	3·4	·4	4·8
Ash ..	·7	·7	·5	·4	2·0	·6	3·7	·6
						Lactic Acid ·6	Lactic Acid 2·0	Lactic Acid ·3

AVERAGE COMPOSITION OF MILK PRODUCTS—*continued.*

—	Condensed Milks.			Milk Powders (Merrell-Soule).			Butter Milk Powder.
	Un-sweetened, ½ Bulk.	Whole Milk sweetened.	Sweet skimmed, ½ Bulk.	Skim Milk.	Whole Milk.	15 per cent. Cream.	
Water	67·0	27·9	27·4	2·4	1·5	·7	2·5
Fat ..	9·7	9·6	·3	1·4	28·2	65·0	8·0
Protein	9·0	10·3	11·6	38·0 (Casein, 30; Alb., 8)	26·0 (Casein, 21; Alb., 5)	13.4 (Casein, 10·6; Alb., 2·8)	34·0
Sugar	12·5	14·0 Lactose; 36·0 Sacch.	13·6 Lactose; 45·0 Sacch.	50·0	40·0	17·8	40·0
Ash ..	1·9	2·0	2·1	8·2	5·9	3·0	9·0 Lactic Acid 6·0

Secret Inks.

By "M."

Secrecy is probably as old as man himself, and from time immemorial men and women have adopted subterfuges to enable them to communicate with each other in a way unintelligible to others. The Greek and Roman military commanders had devised various methods of sending secret messages, and though crude, these probably served their purpose.

A favorite plan was to shave the head of a slave, write a message on his scalp, and despatch him to his destination after the hair had grown again. Another method often used was to send a message on a strip of parchment which could, in those days, only be deciphered when the strip was rolled round a rod of particular shape in the possession of the recipient.

As knowledge accumulated, so the methods of secret communications became correspondingly complex, and to-day the whole range of science has been brought to bear on this exceedingly interesting work. To devise a safe method of secret communication is now a task not unworthy of the best mathematical, chemical and physical brains.

In time of war it is especially important to have safe (*i.e.*, refined) ways of secret communication. The intelligence work of an army, or rather of a nation, is a good index to its fighting power, for modern war machines can act and move so rapidly that it is of paramount importance to acquire accurate information of the enemy's resources and dispositions. It has been said, in effect, that science has altered war from a game of cards to a game of chess.

Broadly, there are two ways of sending a secret message. One is to write it in a selected code, and the other is to write it in a secret ink. The first calls for mathematical skill, the second rather for chemical and physical ability. Sometimes the two methods are combined, but this article will deal only with the latter.

What is a secret or sympathetic ink? It is a fluid in which a perfectly invisible message may be written, but which, after suitable treatment with a "developer," becomes coloured and hence visible. Most schoolboys know that if a message is written on ordinary paper with onion juice, lemon juice or diluted milk, it will be practically invisible when dry, but will show up dark brown if heated with an ordinary iron. The fact that some cobalt salts are almost colourless when cold but highly tinted when hot has long been known, and must have struck many as affording a ready means of secret communication. That morbid genius, Edgar Allan Poe, wrote an interesting story, "The Gold Bug," the plot of which hinges on this fact.

In making an efficient secret message a gold nib must be used, for most invisible inks have an action on steel, and the presence of salts of iron would quite overcome the delicacy of some of the reactions, for some inks are used at a dilution of .001 per cent. It is essential that

the paper should be unglazed, tough and colourless. If glazed paper is used, the solution removes the casein or other filler, and thus becomes visible.

In order to circumvent attempts by prisoners of war to send secret messages, the British military authorities compelled internees to write their letters on special highly-glazed letter heads supplied to them, and any effort to tamper with these could be readily detected with the naked eye. The Germans took no such precautions with their prisoners and internees, and our people were often able to get secret messages through to their homes. Many common substances, such as perfumes, can at a pinch be used for secret writing, and most writing fluids serve as developers for certain inks, so in British camps means were taken to prevent prisoners obtaining such materials. In place of ordinary writing inks those with a carbon basis were supplied.

Usually a secret message is first written on a sheet of paper, and then, to avoid suspicion, an innocent ordinary message is written over and at right angles to it. The secret ink slightly buckles the paper, and to replace the fibres the sheet is held over a jet of steam.

With the exception of inks developed by physical means, such as heat, what one may term a "chromo-reaction" is the basis of secret writing, and, of course, it is not necessary for the developing solution to be colourless. The point is that the developer and the ink react to produce a coloured substance which retains the same form as the invisible writing solution.

Only careful experiment will enable one to find an efficient ink, and often reactions on paper are markedly different from those that occur in test tubes. Needless to say, the developed message must adhere to the paper, and quite a number of inks that promised well have had to be rejected because they failed in this way.

As a simple secret ink, one may cite starch solution. This was often used by prisoners in German camps, because it was so easily obtainable. When painted with a solution of iodine the well-knwon dark-blue colour is developed. Another pair of solutions which, on account of their simplicity, has often been used is copper sulphate and potassium ferrocyanide. Either solution may be used as the ink, but as both are coloured, the fluid must be so dilute that it shows no trace on white paper. A marked development results, but as both solutions can be very easily detected under systematic test, no one but an amateur would use them.

As the study of secret inks developed the search for the ideal medium resolved itself into finding an ink such that it could be used in extremely dilute solution and could only be made visible by one specific developer. Some exhaustive work has been carried out, and a few excellent inks have been discovered. The chemistry of the reactions involved is highly complex, and lack of space and other reasons precludes considering them here. It will be sufficient to say that most of the inks and developers are organic.

One of the most interesting aspects of secret writing is connected with espionage. For a spy to acquire information is one thing, but to

transmit it is quite another. In time of war belligerents, of course, establish censorship of all postal and telegraphic facilities, and a spy finds himself compelled to adopt a subterfuge to evade it. As already explained, this may be by means of code or secret writing. There are many reasons why the latter method is more favoured. Most spies, or, as they are known in official circles, enemy agents, are not of high mental calibre, and they understand very little indeed of the chemistry of secret writing. The agent knows very little of the inner workings of the bureau which employs him, and for purposes of communication he is given an ink of which he knows neither the name nor the developer. For developing the secret message sent to him he is given a developer, but does not know the ink used. As the ink and developer with which he is supplied will not work together, he cannot reveal much information if he is captured.

In disguising materials for secret writing in order to bring them into the country, the agent, or rather his employer, displays considerable ingenuity. Many of the requisite chemicals are difficult to obtain, and in any case to purchase them through the ordinary channels might arouse suspicion. The agent therefore brings them in with his personal belongings. He has to run the gauntlet of a stringent examination at the hands of vigilant naval and Customs officers, and so it is well nigh impossible to conceal even the smallest bottle. One of the espionage bureaux supplies its agents with what is to ordinary appearances tooth-paste, but the tube really contains the ink and insoluble perfumed substances. On adding water to the "paste" the ink dissolves, the other matter sinks to the bottom, and the writing solution can then be decanted off for use. A favorite dodge was to carry the ink disseminated through a cake of ordinary soap. The virtue of this was that the presence of the ink did not prevent the lathering of the soap, and the agent could make an effort to prove the innocence of the material by washing with it.

Later on refinements were devised when it was found that solutions of some of the inks did not affect textiles. Agents would soak their bootlaces, cloth buttons, handkerchiefs, or even their hair, in a solution of ink. When it was wanted for use, what was easier than to soak the article in water for a minute, thus dissolving out the required amount.

As the late war progressed, the problem of combating espionage became increasingly important, and both sides built up as branches of the intelligence service highly-trained departments whose duties were principally to devise safe inks for the use of their own men and efficient methods of detecting and developing the inks used by the enemy. There is now little doubt that our own side usually won. The work was singularly exciting, and the hackneyed phrase, "Romance of Science," gained a new significance.

The systematic testing of letters for the presence of secret messages is quite an intricate problem, for so many factors must be considered. The letters undergoing test could not be detained very long, and the fact that the material on which the operations were to be carried out was paper and might easily be injured somewhat restricted the scope of the tests. Most difficult of all, the possible inks were so diverse that a system of selective testing had to be thought out. Many people who received foreign correspondence in war time must have pondered over

the reason for the presence of rather ugly coloured diagonal stain marks on their letters. These were, of course, the effects of the testing solutions used by the German censors.

Strangely enough, the German methods were usually clumsy and often inefficient, besides which they left the letter in a very soiled condition. The British chemists evolved adequate tests, and after the letter had been treated, the stain marks were usually removed, the letter was washed and ironed, and then sent on to its destination almost in its original state. Some of the chemists could probably give many laundresses a tip or two as to capable work.

There are some inks which are developed by purely physical, as opposed to chemical methods. These at first gave great promise, but they are not used much now, for the majority of them are so active that it is rather easy to detect them.

A solution of a salt of radium was experimented with. This can be used at almost infinite dilution, say one part of the salt in 10,000,000 of water. Now the majority of radium salts are colourless, and in any case the great dilution precludes the use of purely chemical development. One of the chief properties of radio-active substances, however, is their ability to affect a photographic plate, and hence, to get a development, it was only necessary to place the sheet on which the message was written over a photographic plate enclosed in a light tight paper bag. After a space of, say, eight hours—more or less, according to the concentration of the solution used—the plate was developed in the ordinary way. The use of radio-active solutions failed, however, because it is very easy to determine their presence. It is only necessary to bring the suspected sheet near a charged gold-leaf electroscope. If any radio-active substance is present, the leaves of the electroscope fall, owing to the ionizing action of the radiations.

Certain substances show marked fluorescence when exposed to ultra-violet light rays, and this property has found limited application in secret communication. Cases have also been known where a postcard has been split in two, a message written in a substance of high density, and the pieces reunited. When exposed to X-rays, a clear shadow of the message is seen.

There are quite a number of other aspects of the work, but probably enough has been written to indicate that the problem of secret communication is a complex and fascinating one.

Nitrogen Products.

British Committee's Report.

[The final report of the Nitrogen Products Committee has been received, and, in view of the importance of its recommendations, the following abstract has been prepared. Some information upon the general question was given in this journal in the issue of December last by Dr. F. H. Campbell, a member of the special committee appointed by the Institute to work in association with the Nitrogen Products Committee.]

The Nitrogen Products Committee was appointed in June, 1916, as an offshoot of the Munitions Inventions Department, and its functions, in the main, were to consider the relative advantages for Great Britain and for the Empire of the various methods for the fixation of atmospheric nitrogen, from the point of view both of war and peace purposes; and also to consider what steps might with advantage be taken to conserve and increase the national resources in nitrogen-bearing compounds and to limit their wastage.

In a preliminary statement the fundamental importance of combined nitrogen in agriculture is stressed. The war served to emphasize its vital bearing also in relation to munitions. It is pointed out that the world's production of food depends in a large measure upon the application of nitrogen to the soil in the form of nitrogenous manures capable of assimilation by plants, and suitable for varying kinds of soil and climate. Nitrogen is also an essential constituent of nearly all high explosives and propellants, and of many products which play an important part in industry under normal conditions. Before the war the industrial demand for combined nitrogen was quite small in comparison with the agricultural demand. Under war conditions, however, a very large proportion of the world's supply of combined nitrogen was diverted from agriculture to the production of munitions, thus affording a significant lesson as to the extent to which the security of a nation may depend upon its ability to procure or produce an adequate supply of essential nitrogen products. Until recently Chile supplied the greater part of the world's demand for fertilizers with nitrate of soda. Chile nitrate also formed the basis of the products used for industrial purposes.

The continuous increase in the world's demand and the constant upward trend of the price of combined nitrogen led to the invention and development of processes for fixing atmospheric nitrogen, thus opening up a practically unlimited source of supply. Nitrogen gas constitutes about 75 per cent. by weight of the atmosphere, and it is calculated that the air over a single square mile of land contains about 20 million tons, equivalent to about 30 times the quantity of combined nitrogen contained in the world's production of Chile nitrate and ammonium sulphate in the year 1913.

The history of nitrogen fixation dates back to the early years of the nineteenth century, when numerous attempts were made, both in this country and elsewhere, to manufacture cyanides and ferro-cyanides by fixing atmospheric nitrogen with the aid of mixtures of carbon and alkalies or alkaline earths heated to an elevated temperature. Although such cyanide processes have hitherto failed to attain to commercial success, important results have accrued from the researches undertaken in connexion with them, the study of the behaviour of metallic carbides towards nitrogen gas being directly responsible for the technical development of the calcium cyanamide process. In the meanwhile, the work of Sir William Crookes and Lord Ryleigh in Great Britain, some twenty years ago, had first directed attention to the possibility of utilizing the electric arc for effecting the direct oxidation of atmospheric nitrogen on a technical scale for the production of nitric acid. As the result of the progress made in this field of investigation, the arc process was the first of the modern nitrogen fixation processes to be established on a commercial basis, being followed a few years later by the calcium cyanamide process referred to above. The third of the established fixation processes resulted from the researches of Haber and others upon the synthesis of ammonia from hydrogen and nitrogen at elevated pressures and temperatures by the action of catalysts, and was brought into commercial operation in Germany in the year prior to the war. In addition to the three established processes just mentioned, many other methods of fixing atmospheric nitrogen have been tried, and the more important of these are dealt with in the report.

The principal processes in operation or proposed for the manufacture of the more important nitrogenous products admit of a simple classification. The following table indicates the primary and secondary products:—

Processes.	Primary Products.	Secondary Products.
Recovery Processes :		
By-product Ammonia processes	Crude Ammonia Liquor or Ammonium Sulphate (according to the system of recovery adopted)	Other Ammonium Salts
Retort or Chile Nitrate process	Nitric Acid, dilute (65 per cent.) or concentrated (90–96 per cent.) according to method of operation	Nitrates, such as Ammonium Nitrate
Fixation Processes :		
(a) Arc process ..	Oxides of Nitrogen, normally recovered as dilute (30–40 per cent.) Nitric Acid	Concentrated (93–96 per cent.) Nitric Acid, or Nitrates such as Ammonium or Calcium Nitrate
(b) Calcium Cyanamide process	Calcium Cyanamide ..	Ammonia or Ammonium Sulphate : Nitrate of Urea, Guanidine, and other organic products
(c) Haber process ..	Ammonia Liquor ..	Ammonium Sulphate or other Ammonium Salts

PRIMARY AND SECONDARY PRODUCTS—*continued.*

Processes.	Primary Products.	Secondary Products.
Fixation Processes—*contd.*		
(*d*) Cyanide processes ..	Crude Sodium, Barium, or other Metallic Cyanides	Finished Cyanides, or Ammonia or Ammonium Sulphate
(*e*) Häusser and Bender processes	Oxides of Nitrogen normally recovered as dilute (30 per cent.) Nitric Acid	Concentrated (93–96 per cent.) Nitric Acid, or Nitrates such as Ammonium or Calcium Nitrate
(*f*) Serpek process ..	Crude or pure Aluminium Nitride	Ammonia Liquor or Ammonium Sulphate
Conversion Process:		
Ammonia Oxidation process	Oxides of Nitrogen normally recovered as dilute (50–53 per cent.) Nitric Acid or alternatively as Metallic Nitrates	Concentrated (93–96 per cent.) Nitric Acid, or Nitrates such as Ammonium or Calcium Nitrate

Before the war the by-product ammonia industry ranked almost equal in importance with the Chilean nitrate industry. Although the world's production of ammonia nitrogen just before the war was less than the output of nitrate nitrogen, the rate of growth of the by-product industry was even greater than that of the Chilean industry.

The by-product industry was an outcome of the development of the illuminating-gas and coke-oven industries, and its rapid expansion is indicated by the fact that the world's production of ammonia nitrogen (expressed in terms of ammonium sulphate) increased from 540,000 tons in 1903 to about 1,390,000 tons in 1913.

The commercial manufacture of synthetic nitrogen products from atmospheric nitrogen dates from the beginning of the present century with the establishment of the arc process in Norway and afterwards in Austria and Italy. In 1906 the calcium cyanamide process was also successfully established in Italy, and in the subsequent years preceding the war was installed in Germany, Norway, France, Switzerland, America, Austria, Japan, and Sweden. The third of the established methods of fixing nitrogen, the Haber process for the synthesis of ammonia, was brought to a successful stage in Germany in 1913.

With regard to the Haber or synthetic ammonia process, it is reported that the production of the German factory in 1913 amounted to from 30,000 to 35,000 metric tons of ammonium sulphate. There is no doubt as to the commercial success of the process, for steps were being taken before the war to develop it further on a considerable scale. The committee has been informed on good authority that contracts were being made with other countries in the early part of 1914 for the forward selling of large quantities of synthetic ammonium sulphate.

Summarizing the pre-war position, the world's demand for combined nitrogen in 1913 is given as practically double the demand in 1903, about 4,000,000 metric tons of artificial nitrogenous fertilizers being consumed in 1913.

Practically the whole of the world's demand was met by the Chile nitrate and by-product ammonia industries, the output of the synthetic industry being relatively insignificant in spite of its notable development during the years 1903 to 1913.

The relation between the output of ammonia nitrogen and of nitrate nitrogen was undergoing modification on account of the rapid growth of the by-product industry, which expanded by more than 150 per cent. during the period 1903-1913 as compared with an expansion of over 70 per cent. in the case of the Chile nitrate industry.

The Chile nitrate industry provided about two-thirds of the world's supplies of combined nitrogen in 1903, and about three-fifths in 1913, the market price of the nitrate governing that of combined nitrogen.

The market price of combined nitrogen during the years 1903-1913, although showing considerable fluctuations, was characterized by a general upward tendency.

The synthetic industry, although in its infancy, was in a position to place nitrogenous fertilizers upon the market at a price comparing not unfavorably with the current market prices of nitrate and ammonia nitrogen.

The war, however, has been responsible for profound modifications in the relative positions of the nitrogen industries, the special combination of circumstances characterizing the war having led to an enormous expansion of the nitrogen fixation processes. It has been found that, in consequence of recent developments, the estimated productive capacity of the nitrogen fixation installations represented about 10 per cent. of the world's supplies of combined nitrogen in 1914, and has grown to about 28 per cent. at the present time. The post-war production of ammonium sulphate, both synthetic and by-product, may account for about 39 per cent. of the world's supplies of fixed nitrogen as compared with a figure of 41 per cent. for Chile nitrate. The supremacy of the Chilean nitrate industry is already being challenged on account of the war developments, and the near future holds out the prospect that the market price of ammonium sulphate or of synthetic products may govern that of Chile nitrate instead of following it as hitherto. While the post-war supply of fixed nitrogen potentially available for the world's requirements is likely to be of the order of 1,000,000 metric tons or over per annum, an increase of from 30 to 40 per cent. upon the pre-war production, the total increase in the world's productive capacity during the war period does not appear to be greater than would have been the case under normal conditions had the ordinary rate of growth in consumption in the pre-war period been maintained during the last four years.

It is, perhaps, a matter for surprise that the total increase has not been greater, in accordance with general impressions of the position. The explanation is clearly seen to be that there has been a relatively small expansion of the two major industries during the war, the great development having been confined to synthetic processes which were only responsible for an insignificant proportion of the world's supplies before the war.

NITROGEN PRODUCTS.

The question of over-production is not regarded as likely to constitute a serious factor in the post-war situation. Special attention is drawn to the relative costs of synthetic and non-synthetic processes, and it is shown that, under favorable conditions in regard to the cost of power and of raw materials, the nitrogen fixation and allied processes, speaking broadly, stand at a very considerable advantage as compared with non-synthetic methods. Upon the basis of pre-war market prices and factory costs it is pointed out, *inter alia*, that the market price of a metric ton of combined nitrogen in the United Kingdom before the war (average 1911-13) was £67 and £66 in the forms of Chile nitrate and ammonium sulphate respectively, and that the synthetic processes can produce a metric ton of combined nitrogen at a cost, at the factory, of from £20 to £30. Further, the synthetic processes can produce a metric ton of concentrated (93 to 96 per cent.) nitric acid for about half the cost by the Chile nitrate retort process.

Considering the international situation after the war it is pointed out that there will probably be ample scope in the post-war markets for all forms of nitrogenous fertilizers, both non-synthetic and synthetic, and it is thought that the industrial demand for nitric acid is likely to be met in the future by means of synthetic processes which show to considerable advantage as compared with the Chile nitrate retort process. The marketing of large quantities of synthetic ammonium sulphate and calcium cyanamide as the result of further developments of the Haber and cyanamide processes must influence the price of combined nitrogen and may even control it. Consequently the Chilean nitrate industry, in order to hold its position against the cheapest synthetic fertilizers, may be faced with the necessity of making substantial reductions in price, perhaps to a figure of £8 per ton, or even less.

It is thought that the economic and financial position of Germany during the years succeeding the war, and the essential need of nitrate fertilizers for restoring her agriculture, may induce, or even compel, that country to resort to the manufacture of synthetic nitrates. The Chilean industry may thus be faced with the partial, or even total loss, of the German market, which was the largest individual market before the war.

In making the recommendations set out below, the Committee was guided by the following salient facts:—

(*a*) The sources of supply of combined nitrogen in the United Kingdom must be increased considerably if the existing and prospective home demands are to be met, and the pre-war scale of exportation is to be maintained.

(*b*) The existing sources of supply of combined nitrogen in the United Kingdom proved wholly inadequate for meeting the war demands.

(*c*) The risks and costs of importation during war are very serious.

(*d*) Combined nitrogen (as cyanamide or ammonium sulphate) can be obtained by synthetic processes at a cost, at the factory, which is less than half the market price of combined nitrogen from other sources, pre-war conditions being taken as the basis in each case.

(*e*) Concentrated nitric acid can be made by synthetic processes for about half the pre-war cost by the standard retort process *viâ* Chile nitrate.

(*f*) The ammonia oxidation process provides a means whereby, during a state of war, the importation of Chile nitrate would be rendered unnecessary.

(*g*) The world's demand for combined nitrogen appears to double every ten years. The increased production during the war has not been more than the normal rate of increase during peace.

(*h*) The actual consumption of combined nitrogen for agriculture in the United Kingdom has practically doubled during the war, and there is certain to be a further increase.

(*i*) No very large increase in the output of by-product ammonia in Great Britain in the immediate future seems probable.

The specific recommendations of the Committee are set out under various headings, and it will be observed that they embody the main recommendations put forward in the interim report.

The following measures are recommended as a minimum provision for safeguarding the future and for meeting a portion of the growing home demand for various nitrogen products:—(1) The establishment in Great Britain without delay of the calcium cyanamide process either by private enterprise (supported, if necessary, by the Government) or as a public work; (2) the scale of manufacture should be sufficient to give an output of about 60,000 tons of cyanamide per annum, equivalent on the basis of combined nitrogen to about one-eighth of the present home production of ammonium sulphate; (3) the necessary electrical energy should be obtained either from water power in Scotland or from a large steam-power station.

The Committee has ascertained from the Water Power Resources Committee of the Board of Trade that there are several sites in Scotland where the necessary water power can be developed at a reasonable cost. If steam power is used, a suitable site for the cyanamide factory might be obtained at one of the capital power stations proposed by the Board of Trade Committee on Electric Power Supply.

The synthetic ammonia (Haber) process has hitherto only been operated on a full commercial scale in Germany. Nevertheless, as a result of the continuous experiments carried out since the summer of 1916 at the Research Laboratory of the Munitions Inventions Department, the Government decided early in 1918 to erect a large factory at Billingham-on-Tees for the manufacture of synthetic ammonia and ammonium nitrate. This factory, projected as an emergency war measure, did not reach an advanced stage through causes which it is unnecessary to specify, and in view of the altered situation the need for the completion of the factory as an ammonium nitrate project no longer exists. The Committee nevertheless recommends that the synthetic ammonia process should be established forthwith on a commercial unit scale, and extended as rapidly as possible, as a post-war measure, up to a minimum manufacturing scale of 10,000 tons of ammonia (equivalent to 40,000 tons of ammonium sulphate) per annum. The Billingham factory should be utilized for the purpose if such a course is practicable.

NITROGEN PRODUCTS.

The ammonia oxidation process, in its modern developments, has been proved to afford a reliable and simple means of obtaining nitric acid and nitrates. Early in the war, a full-scale installation was erected on the Thames by private enterprise, supported by the Government, the older method of oxidation being utilized. A long series of experiments carried out at the Research Laboratory of the Department resulted in the design of a simple and modified plant which has been installed on a trial scale at several works in the country. The designs of the ammonia oxidation section of the Government ammonium nitrate factory referred to above were based upon the results obtained in these research and trial operations. The Committee recommends that an ammonia oxidation plant should be completed in conjunction with the synthetic ammonia factory already referred to, as was originally contemplated by the Government, on a scale sufficient to produce about 10,000 tons of strong nitric acid per annum, or its equivalent in nitrates. The plant should be designed to utilize either synthetic or by-product ammonia as a raw material, because the national interests demand that adequate experience in the production of nitric acid from ammonia from all sources should be available in Great Britain.

The Committee makes the following recommendations for conserving and increasing the output of combined nitrogen from existing by-product ammonia industries, for securing the better utilization of the national resources in coal, and for reducing the consumption of raw coal as a fuel.

The Committee recommends that:—

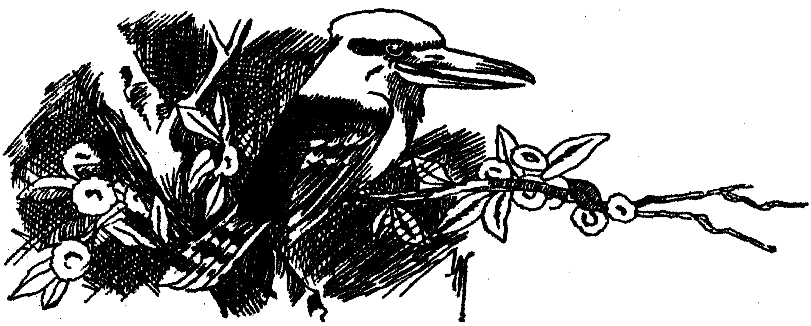
(1) Encouragement should be given to facilitate and to insure the replacement of non-recovery coke-ovens by recovery ovens at a much more rapid rate than hitherto, in order that the reserves of coking coal shall be utilized to the maximum advantage.

(2) It should be incumbent on all gasworks which now contribute to the home supplies of ammonia nitrogen to put into practice the various simple expedients that have been proved to result in a considerable diminution in the loss of ammonia by volatilization or otherwise. The statutory powers administered by the Local Government Board through the Chief Inspector of Alkali Works should, if necessary, be extended to insure that this is done.

(3) In collaboration with the responsible organization of the gas industry, a comprehensive scheme of ammonia recovery and collection (including distribution of sulphuric acid) should be devised, which will be economically applicable to as many as possible of the smaller works where ammonia is at present allowed to run to waste. Wherever it can be shown that no financial loss would be incurred by any works included in the scheme, the works should be required, in the national interests, to co-operate. When a scheme has been devised, powers should, if necessary, be conferred upon the Local Government Board to insure its operation and administration.

(4) In collaboration with the responsible organizations of the by-product ammonia industries, definite standards of efficiency in ammonia recovery should be formulated (based upon the qualities of coal in use and upon good average practice realized under the conditions in force at by-product recovery installations of various classes and sizes), and all works contributing towards the home supplies of ammonia should be required to conform to appropriate standards of recovery. When such standards have been formulated, powers should, if necessary, be conferred upon the Local Government Board to insure their observance.

(5) Encouragement should be given to all efforts to extend the use of coal gas and coke in the place of raw coal for domestic purposes, for steam-raising, and for other industrial requirements.



Rapid and Economical Methods of House Building.

PISÉ DE TERRE.*

By CLOUGH WILLIAMS-ELLIS.

During the past few months a great deal has appeared in various newspapers about pisé de terre. Much information has been given, but not all of it is accurate. The public has, for instance, been informed that pisé de terre is the same as cob, that it is a method of building with pulverized-breeze, and that it is, at the same time, "monolithic," and built up of blocks cemented together. All these things are interesting, but not true. The following is the veracious history of pisé de terre, as far as I know it.

We first hear of pisé de terre in Pliny's *Natural History*, where he remarks that Hannibal, three hundred years before, had built watch-towers in Spain of earth rammed between shutters, and that these towers still stood intact. It has been widely used in the district round Lyons, where houses three stories high, and even churches, are built of pisé. Recently, it has been employed in India, in New South Wales, and in Rhodesia, and in 1915 experiments in pisé were made in this country by Mr. Strachey at Newlands Corner, Merrow, near Guildford. This year I have built a pisé small-holder's house and steading for Mr. Strachey, and it is to the interest aroused by this house and the publication of my book that the curious paragraphs above referred to have been mainly due.

Pisé is merely earth to which nothing whatever is added. The earth is dug and thrown between wooden boards and rammed till it is perfectly hard and compact—until, in fact, what is practically an artificial sandstone has been created. The earth is thrown into these shutters in layers of 5 inches or 6 inches, and then rammed (by men standing inside the casing) until it is thoroughly solid, before another layer is added. When the mould is full of rammed earth, and the rammer no longer makes an impression, the casing is taken apart and re-erected on the top of the wall just completed.

As to the soil, if it is too sandy it will fret away, while a pure clay soil will crack in drying, and both these exceptional extremes should, therefore, be avoided. Any other soil, however, is more or less suitable, and even clay and sand may be used if they are mixed together, the peculiarities of the one counteracting those of the other.

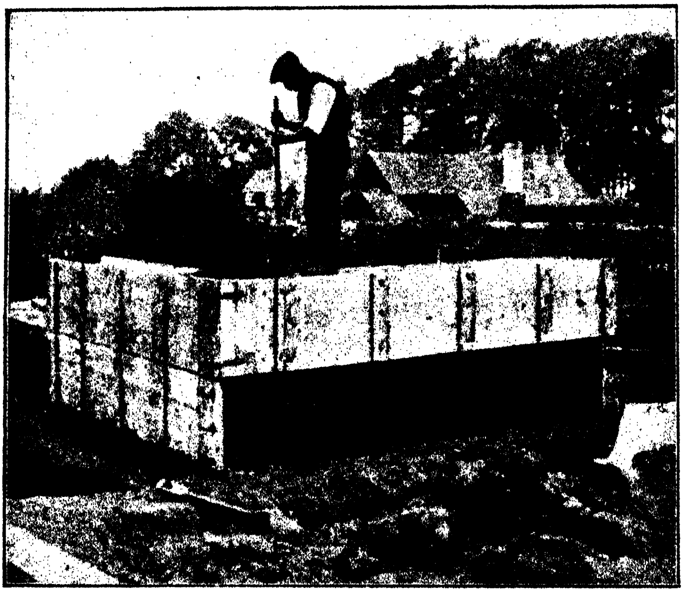
The plant for pisé building consists of two pairs of casings or shutters, with stops that may be inserted in such a way that gaps in the walling can be left for doors and windows; a "corner-piece," an "end-piece," and a set of two or three wooden rammers. It is most important that the shuttering should be perfectly rigid and true, as upon its rigidity depends its ability to withstand proper ramming, and consequently the straightness and strength of the walling. The shuttering described in the old books upon pisé was extremely primitive.

* This article is reprinted from the *Architects Journal and Architectural Engineering*, Vol. L., No. 1304.

"For the construction of the mould take several planks, each 10 feet long, of light wood in order that the mould may be easy to handle. Of these planks, something over 1 inch thick after planing, fastened together with four strong ledges on each side, the mould must be made 2 ft. 9 in. in height, and two handles should be fixed to each side.

"The instrument with which the earth is rammed into the mould is a tool of the greatest consequence. It is called a pisoir or rammer; and though it may appear very easy to make it, more difficulty will be found in the execution than is at first apprehended. It should be made of hard wood, either ash, oak, beech, walnut, &c., or, what is preferable, the roots of any of them."

Pisé building lay off the great main stream of constructional activity; and the enterprise and ingenuity lavished on the perfecting



RAMMING PISÉ WALLS.

From "Cottage Building in Cob, Pisé, Chalk, and Clay," by Clough Williams-Ellis.

of other building gear and materials passed pisé by, leaving it undisturbed in its quiet backwater, a primitive system still with its primitive tackle.

I myself, however, designed a new plant, which is a considerable advance upon the one described above. It is with such a set of shuttering which I called "Mark V." that the walls of the Newlands Corner Cottage were built, but in the light of the experience gained in putting up this building I have designed "Mark VIII.," which will, I think, prove as much superior to "Mark V." as "Mark V." did to the "aboriginal" shuttering. "Mark VI." and "Mark VII." were abortive designs that got little further than the drawing board.

Next to the use of rigid casing, the success of the work depends upon the freeing of the soil from the larger stones and upon its thorough

ramming, but provided it be conscientiously carried out the work is extremely easy and almost all of it—even the adjustment of the shuttering—can be carried out by unskilled labour. The pisé walling for the house at Newlands Corner was put up, under my supervision, in twenty-six days by two unskilled men, men who had had no previous experience of pisé work or, indeed, of any other building. The cost of the pisé house-walls came to under £20, and this sum was, of course, merely the wages bill for the two men, the material used for the walling being dug on the spot. The estimate for the same run of walling in brickwork was over £200. At Newlands Corner I used a brick footing and a slate damp-course, but this was an unnecessary extravagance. In later buildings the pisé is imposed direct on the concrete, save for the intervention of a bitumen-sheet damp-course.

The use of a pliable damp-course in place of slates does away with the brick-course that was necessary above the latter to protect it from fracture by ramming. When the walls had been up for less than two months they were dry enough for the house to be occupied with perfect impunity. It is noteworthy that the walls of the first rough shed put up by Mr. Strachey in 1915 are now so hard that it is difficult to make any impression on them with a knife or hammer.

It is stated in the old books that it is well to protect pisé by good eaves, and I therefore obediently took this precaution in designing the small-holder's house. Mr. Strachey, however, in building his shed left the gable end entirely unprotected, where it was further exposed to the drip of a tree. The wall has not suffered in the least, and no damp whatever has penetrated.

When they are up the walls can be plain colour-washed, cement-rendered, plastered rough-cast, or sprayed with hot tar, and subsequently colour-washed on the top. I think that with the improved shuttering and the smooth surface that results, it will be possible to paper the interior walls directly without the interposition of plaster.

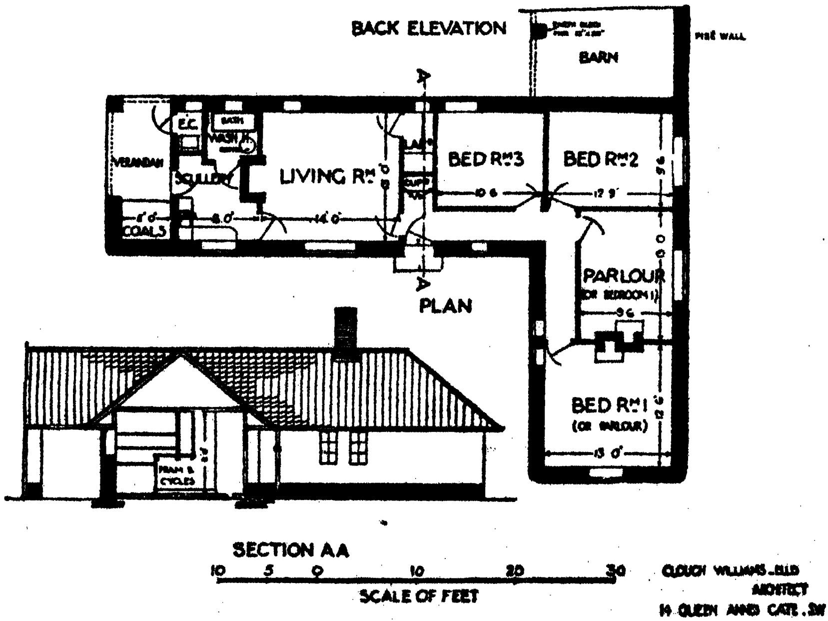
It is, perhaps, unnecessary to insist upon the non-conducting properties of earth to a nation which banks up its potatoes in winter. Pisé, as is to be expected, compares extremely favorably in this respect with all the materials used for walling, quite apart from the extra thickness usually implied by its use.

Every one, except a certain section of the press and its docile public, is alive to the imperfection of wood houses in regard to heat and cold, even if suitable wood for the construction were readily available, which it is, most emphatically *not*. Aware of our own timber shortage, I was still considerably surprised by receiving a number of letters from Canada and Scandinavia stating that, owing to the lumber shortage, the freight difficulties, and the various drawbacks attaching to log or frame houses, the possibilities of pisé building were receiving wide attention; my *Spectator* articles on the subject having, for instance, been quoted at length in Swedish newspapers.

The "wooden house" press has told us to turn our eyes to these very countries, for from thence should come our salvation.

When one finds that they are themselves turning to pisé as an alternative to the use of their gravely reduced timber stocks, one is tempted to rebuke the optimists not so much for barking up the wrong tree as for attempting to climb one that is not there.

(By Courtesy of "Country Life.")



PISÉ COTTAGE AT NEWLANDS CORNER, SURREY.

Clough Williams-Ellis, Architect.

Certain paragraphs in the press appear to have given the impression in some quarters that there was a sort of secret or patent about pisé. There is, of course, nothing of the sort; it is, indeed, the simplest of all methods of building, and at least thirty centuries old.

All I have so far contributed personally are certain minor improvements in plant and procedure that I hope may very soon be eclipsed by the ingenuity and enterprise of others.

Meanwhile, however, a few extracts from the specification of my Newlands house may prove of service to fellow-pioneers.

Specification.—The following is an abridged extract from the specification so far as it affects the pisé builder:—

(1) Excavate to a depth of 9 inches over the site, dumping the turf and surface humus where directed.

This soil is not to be used for building.

(2) Lay a 6-inch bed of cement and flint concrete 3 feet wide under outer walls. Centrally on this lay two courses of brickwork in cement to a width of 18 inches, or build up to the same extent in concrete.

Lay on this an approved damp-proof course; if of slates, having a further course of brickwork or concrete above it to prevent fracture when ramming.

(3) Erect the walls according to the plan on the bases thus formed, carrying them up plumb and true and properly bonded by working round the building course by course, using the special-angle pieces at the corners to keep the work continuous and homogeneous.

(4) All stones and flints above a walnut size to be removed by riddling and reserved for concrete.

All sticks, leaves, roots, and other vegetable matter to be eliminated.

(5) The soil immediately on the site to be used without admixture of any sort and to be thrown direct into the shutterings.

No water to be added without the express permission of the architect.

(6) The boxes are to be filled in thin layers of not more than 4 inches at a time, and well rammed until solid. The workmen are not to use their rammers in unison.

(7) Rammed earth at box ends to be shaved down to a 45-degree slope so as to splice in with new span of pisé adjoining it.

Where door and window openings occur, the special "stops" to be adjusted and firmly secured so as to withstand hard ramming. Two 4-inch by 2-inch by 9-inch plugs to be built in to each window jamb for the securing of the frames and three to each door jamb.

Special care to be taken in the thorough ramming at the corners and along the box edges.

(8) Insert below floor level where directed twenty-four 3-inch field drainage pipes to act as ventilators through the thickness of the wall. Insert wire mesh stops to exclude vermin.

(9) Set all frames square and plumb, and where in outer walls, flush with finished exterior plaster-face, the joint being covered by a 2-inch by ¾-inch fillet.

Where lintels occur, they are to be tailed in at least 9 inches on each side the opening.

Provide plain picture rail round all rooms at window-head level, providing plugs for fixing where necessary.

Secure to floor round all boarded rooms a 2-inch by 1½-inch angle fillet as skirting.

(10) The smooth surface of the pisé walling to be hammer-chipped to give a good key to the plaster.

Before rendering or plastering walls, any loose earth or dust to be removed with a stiff brush and the wall surface evenly wetted.

The rendering to be carried evenly round the walls—the minor square angles being roughly chipped down first so as to obviate sharp corners. The main corners of the house are ready-rounded off to a 9-inch radius by the special corner mould.

(11) Bond brick and slab work to pisé walls by driving iron spikes into the latter every few courses at joint level and bedding in.

(12) Colour-wash walls with tallow lime-whiting tinted with ochre. Provide 2-feet skirting of pitch, applied hot, to form base-course round exterior of building.

N.B.—The exterior of the walls of the Newlands Corner house are being finished in several different ways, with a view to determining the most durable and economical form of epidermis.

A trial pisé building adjoining has stood for four years without any external protection whatever. It has suffered no damage and grows continually harder. For the sake of appearances, however, and for the better preservation of the wall from chance injury whilst still "green," a coating of some sort may be deemed necessary.

Cattle Breeding in Denmark.*

By LARS FREDERIKSEN.

A peninsula—Jutland—and a number of small islands, of which Seeland and Funen are the largest, no high mountains or large rivers, no coal, no iron, or other mining products, 15,300 square miles of almost level—in many parts of the country rather poor and sandy—land, partly covered with woods or heather, but as a rule used for agricultural purposes—that is Denmark. Only a little more than one-half the size of the island of Tasmania. The population is about 3,000,000. If a foreigner recognises Denmark in the world's doings, it might be on account of the name of Hans Christian Andersen and his fairy tales; or it might be for the reputation of the butter and bacon sent from Denmark to the English market. The attention of many is drawn to Denmark on account of the co-operative movement in the Danish system of farming. Before talking about cattle and cattle-breeding, I desire to say a few words about that system of agricultural co-operation.

An English author (Sir H. Rider Haggard) a few years ago asked the question, "Where would Danish agriculture be to-day if co-operation had not been introduced into that country?" If Danish farmers had not learned the art of co-operation, of working together, Denmark would have been a poor little country, for its agricultural wealth to-day depends almost exclusively on the co-operative movement. As you know, the idea of co-operation is not a Danish one, but an English. Robert Owen is the recognised founder of the co-operative movement in England, and the working men in Rochdale opened their store in 1844, a good many years before the idea of co-operation was introduced into Danish agriculture. If Denmark has a good reputation in the agricultural world, it is owing to the way in which co-operation is practised in Danish farming. The cultivation of the soil, the breeds of live stock, the whole technical system of farming in Denmark, is no better than, if it is as good as, in many other parts of the world. What characterizes the development of Danish agriculture in the last 30 to 40 years is the co-operative movement. The success of co-operative farming in Denmark depends on several conditions, and I shall try to explain a few of the main reasons which account for the great development experienced here.

First of all, most of the farmers in Denmark possess their own land, they are freeholders. In England, as in a good many other countries, a large part of the land belongs to landlords, to a few people, who own most of the country and rent the land to the farmers. One of the main conditions for successful agricultural co-operation is, as far as my knowledge goes, that the farmers should own their homes and land, as a rent-paying farmer is always more or less a stranger to the land from which he makes his living.

* Lecture delivered to visiting members of the A.I.F. by the expert in cattle breeding for United Agricultural Societies of Jutland.

Another point that ought to be taken into consideration is the size of the farms and the uniformity of the system of farming. There are about 250,000 farms and cottages in Denmark. Of these only 9,000 farms consist of more than 148 acres; 61,000 between 37 to 148 acres—and one-half the agricultural area of the country belongs to this group of medium-sized farms; 47,000 farms have from 12.3 to 37 acres of land; and 133,000 farms have less than 12.3 acres, or no land at all.

AREA OF FARMS IN DENMARK.

Size of Farms.	Number of Farms.	Area in—		Percentage of the Entire Area.
		Hectares.	Acres.	
Acres.				
0·0 – 1·35 ..	68,380	9,513	23,507	0·1
1·35– 12·3 ..	65,222	166,757	413,066	4·6
12·3 – 37·0 ..	46,615	420,308	1,058,374	11·9
37·0 –148·0 ..	60,872	1,808,625	4,469,219	50·2
148·0 –593·0 ..	8,072	769,814	1,902,256	21·4
Above 593·0 ..	822	425,555	1,051,571	11·8
Total ..	249,983	3,608,572	8,916,994	100·0

The tendency now is in the direction of increasing the number and decreasing the size of the farms. Incorporation of farms is forbidden by law. Practically all the farms in Denmark are worked in the same way. As a rule, all farmers keep cows and pigs—the farms without cattle and pigs are exceptions. This is another of the reasons why the co-operative movement has had such a success in this country. Besides the freehold, the size of the farms, and the uniformity in the system of farming, it must be mentioned that the spirit of the people forms the very best foundation for a good development of the idea of co-operation. As something typically Danish, we have what is called the people's high schools. Indirectly—and to a certain extent also directly—those schools have done a lot of good for the development of agriculture in Denmark in the last half-century. Thirty or forty years ago, Denmark was in a rather bad condition as far as agriculture was concerned. Owing to a war with Germany, the country was deprived of two of her richest provinces; the natural fertility of the soil was lost, and much cheaply-produced corn and grain came from the Trans-Atlantic countries into the European market, and reduced the prices of grain to such an extent that selling grain would not pay for the rent. It was a hard time for the country, especially for the farmers. The price of the land decreased, and many old farmer-families lost their wealth. The only thing to be done was to produce something besides grain, to change the system of farming in order to bring the fertility back to the soil and produce a high-priced market product—and Danish farmers turned to co-operative dairying. In 1882, the first co-operative creamery was established in the west of Jutland; since then, there have been co-operative creameries established in almost every township in the country. Altogether, we have now in Denmark about 1,230 co-operative creameries.

The co-operative creameries made it possible for all farmers, even the smallest with only one cow, to obtain good prices for their butter. By this means, it was made possible to send to the English market Danish butter of a good and uniform quality, and to build up a reputation for Denmark. The next thing was to produce more butter. This required more feeding stuff, more and better cows. On that account, the farmers commenced—

(a) To produce heavier crops from their own fields by better rotation, especially by the extension of the area cultivated with root crops, and by the use of commercial fertilizers.

(b) To buy and use commercial feeding-stuffs, such as oil cakes, and corn.

(c) To improve their live stock, especially the cattle and pigs, also the horses.

The results of this work are shown by the following figures concerning the export of live stock products and import of feeding-stuffs from 1876 to 1914:—

—	Surplus Export of Live Stock Products.	Surplus Import of Feeding Stuffs.	Difference.
	Mill. Kr.*	Mill. Kr.*	Mill. Kr.*
1876–1880	66	24	42
1881–1885	80	5	75
1886–1890	100	24	76
1891–1895	141	40	101
1896–1905	259	100	159
1906	289	131	158
1907	310	135	175
1908	337	132	205
1909	346	151	195
1910	380	128	252
1911	384	138	246
1912	454	179	275
1913	492	184	308
1914	619	136	483

* 1 Krone nominally = 1s. 1½d.

The main part of the money in the first column came from England in payment for butter, bacon, and eggs. The last column indicates the difference between the value of the surplus export of live stock products and the value of the surplus import of feeding-stuffs. It would be right to say that, to a certain extent, the difference means the amount of money which the Danish farmers have received for their home-produced stuffs, for care and management of the live stock. Denmark makes use of four different breeds of cattle, two native and two English:—

1. The Black and White Jutland cattle.
2. The Red Danish Dairy Breed.
3. The Shorthorn (dual purpose).
4. The Jersey.

The cattle of Jutland were in earlier days known for their juicy and marbled beef. The characteristic colour of the Jutland breed is black and white, a few, however, being grey and white. In the beginning and the middle of the 19th century, all kinds of cattle, such as Brown Swiss, Holstein, Ayrshire, Aberdeen, Angus, Galloway, and Shorthorn, were imported to Denmark, and also to Jutland, for crossing-up the native breeds. This crossing, however, at that time, did not result in an improvement, and was, therefore, discontinued; and the breeders started to improve the home breed. To-day, the Jutland cattle can be characterized as a dual-purpose breed, producing a fairly good quality of beef. In addition, the mature cows yield in average about 3,000 kg. of milk, with about 3.5 to 3.6 per cent. of fat. The very best cows produce as much as 7,000 kg.* of milk and 300 kg. of fat in a year. A good many herds have an average production of 4,000 kg. milk, and 200 kg. butter is not unknown for the entire herd of mature cows. Fifty years ago, the average production of the Danish cows was something like 1,100 kg. of milk and about 45 kg. of fat in a year; to-day, it is three to four times as much.

The red Danish dairy breed are found in the south-eastern parts of Jutland, and on the islands. The colour is soil red, and their name shows that the cattle are of the dairy type. The average cows of the red Danish breed produce a little more milk and butter than those of the Jutland breed; on the other hand, the Jutland breed may be a little better as beef-producers. The Jerseys are scattered all over the country, but only a very few herds are found. Of Shorthorn cattle, there are quite a number, especially in the south-western parts of Jutland; and it seems as if in the last years they have covered more and more ground, for there are to-day Shorthorn cattle in most parts of Jutland. The native breeds are still far the most common. On the islands, the red Danish dairy breed is—taken as a whole—the only common breed of cattle; and in Jutland the black and white native breed is still the most numerous.

About the same time as the first co-operative creamery was established, the first cattle-breeding association was started. The aim of the associations is to promote a rapid improvement in and development of the cattle in the community by the purchase of one or more bulls of recognised breeding. The bulls are supposed to be used for the very best cows in the association.

The term "good bull" or "good cow" does not apply only to a sound, well-built, fine-looking animal, for if a cow belonging to the dairy type should be called "good," it must be, in addition, a good producer. One of the main factors in the breeding of dairy cattle is the ability of the cows to produce milk. The nicest-looking dairy cow may be a poor producer, while a rather tough-looking animal can be a good producer. For that reason, the dairy farmers have to keep records of their milking cows. On the larger farms, such records have been kept for more than half a century, but on the smaller farms it was not a common thing to keep milk records until we got cow-testing associations.

* 1 Kilogramme = 2·2 lbs.; 7,000 kg. therefore = 15,400 lbs., or 1,540 gallons.

CATTLE BREEDING IN DENMARK.

The aim of the Cow-testing Association is, first of all, to let the owner know how much milk and butter each of his cows produces; next, it is to inform the farmer of the remunerativeness of each cow, and of the herd as a whole. In other words, the Cow-testing Association tells the farmer which cows to breed from, and which cow gives the best return for the feeding-stuff she has consumed. But, besides that, the Cow-testing Association has another very important purpose, and that is to keep records of the breeding in the herd. In some of the associations they also keep records of the cost of feeding and raising the calves and young stock, of producing pork, and of keeping the horses. And in the most advanced associations, they also keep records of the yields from the different fields planted with different crops. The work in the association is done by a tester—in Denmark called a control-assistant. This means that he is to assist the farmer in controlling his dairy herd, or, in some cases, all his live stock and the remunerativeness of the whole farm. As a rule, the cow-testers are young men trained for that special work, most of them having been pupils at agricultural schools. What the tester does is, first of all, to identify the cows, weigh the milk of each milking for the 24 hours, test a composite sample of the milk for the amount of butter-fat, weigh or calculate the amount of food consumed by each cow, and enter all the figures in the record-book, which has a page for each cow.

The tester visits the members of the association once or twice a month; each time he has to mark calves born since his last visit, notice the date of birth, and the sex of the calf, and its sire and dam. The numbering of the calves is done by marking the ears. To-day there are about 700 cow-testing associations, with 16,500 members, who own 225,000, or one-quarter, of all the cows in Denmark. Each cow-testing association receives in Government aid 200 kr. per annum. In order to obtain this, the associations must have at least ten members, owning in all at least 200 cows; also, the local testing association must be a member of an organization for the cattle-breeders and cow-testing associations in the district. The purpose of the district organizations for cattle-breeding, as well as for cow-testing associations, is that they, in co-operation with other agricultural societies, shall promote cattle-breeding in the district. As a rule, the district organizations ("Fælle-sledelser") engage a cattle expert or adviser. The duty of the expert is to take part in meetings and fairs, to assist the local associations in all their work, especially in the purchasing of bulls; to look after and assist the tester in the cow-testing associations. In addition, he has charge of the keeping of herd-books for the improvement of the herds under the organization. The district organizations work in conjunction with the united agricultural societies of the province. A cattle-breeding or cow-testing association cannot get any Government aid without being recommended by the district, and also the provincial organization. At the end of each fiscal year, the cow-testing associations have to report on the work done. Through the district organization, they have to send to the united agricultural societies of the province information as to the breed of each of the cows tested, the number or name of the cow, her sire and dam, her date of calving, the sex of the calf, and for what purpose the calf is used. Besides this,

they have to give the figures for kg. of milk, percentage of fat, kg. of butter, kg. of milk with 1 per cent. of butter-fat, and number of food units consumed.

It is the duty of the provincial organizations to publish those parts of the reports which are of interest in the promotion of dairy cattle-breeding.

In Jutland, the reports are dealt with in two different ways: Firstly, all the cows which have produced more than 175 kg. of butter in the last year are picked out, and then a card is filled out for each cow which has a herd-book bull as sire. This last work is the most important for the breeding. By its means, we try to find which of the herd-book bulls give the best offspring as far as the production of milk and butter is concerned. We find quite a difference in the bull's value as breeder of milch cows. The offspring of some bulls give less milk and butter than the mothers of the offspring did.

I shall try to explain the different breeding values of the bulls by an example:—A bull, herd-book No. 1529, had 11 daughters tested. On an average, the 11 daughters, after their first calving, produced 2,405 kg. milk, 3.42 per cent. fat, and 92 kg. butter. The dams of those young cows after their first calving produced 2,735 kg. milk, 3.75 per cent. fat, and 115 kg. butter. In other words, the offspring produced after the first calving, 330 kg. milk, 0.33 per cent. fat, and 23 kg. butter less than their dams did. Such a bull has a negative value for breeding purposes, for he decreases the produce of his offspring compared with the production of the cows. On the other hand, we have bulls that increase the production of their offspring. A bull named "Emb Britten" had 18 daughters, the average production of which in 46 years was 3,095 kg. milk, 3.71 per cent. fat, and 128 kg. butter. The dams of these 18 cows, in the same 46 years, produced 2,791 kg. milk, 3.36 per cent. fat, and 105 kg. butter. This means that the bull increased the production of his daughters by 304 kg. milk, 0.35 per cent. fat, and 23 kg. butter. This bull, "Emb Britten," has thus increased the production of his daughters by about as much as herd-book No. 1529 had decreased the yield of his daughters. For the breeding of dairy cattle in the future, investigations of this kind are of high value; and I suppose that one of the main purposes of the cow-testing associations is to produce the material necessary for an investigation of the productive ability of the offspring of the bulls used.

Besides statistics concerning the production of the daughters of the herd-book bulls, we also keep records of the sons of the herd-book bulls. Each son which has received a prize at a Government or provincial show, or belongs to a cattle-breeding association, is registered on a card. In that way, we get information of almost all the offspring of the herd-book bulls, and have an opportunity of judging their breeding value, which is one of the main points in all kinds of breeding. But we could not do that without the records of the cow-testing associations. In other words, the cow-testing associations are the basis of the breeding of dairy cattle in this country.

A bull of dairy type cannot get a prize at a show in this country without the records of its dam being known. In the catalogue there is the record of each bull's female ancestors, and great attention is paid

to this information. It has a great influence on the prices paid for the bull. Here, in Jutland, the bulls of dairy type are judged from three different points:—(1) The animal itself; (2) the record of his female ancestors; (3) the pedigree.

The following table shows the increase in live stock from 1861 to 1918, in thousands:—

	Horses.	Total.	Milk Cows.	
1861	325	1,121	757	304
1888	376	1,460	954	771
1893	411	1,696	1,011	829
1903	487	1,840	1,089	1,457
1909	535	2,254	1,282	1,468
1914	567	2,463	1,310	2,497
1918	545	2,123	1,024	621

In 1914, Denmark exported 644,000,000 kr. worth of live stock products, 39,000,000 kr. worth of other agricultural products; and 97,000,000 kr. worth of all other products (not agricultural). The total export in 1914 amounted to 780,000,000 kr., of which 82.6 per cent. were for live stock products, 5 per cent. for other agricultural products, and only 12.4 per cent. for all other kinds of Danish products exported in the year 1914. The export from Denmark depends almost entirely upon the live stock products. This industry, in the years before the war, was the main factor in the Danish commercial life; and we believe that the live stock in the coming years will also be of great value all over the world.

Personal.

PROFESSOR RENNIE, M.A., D.Sc.

Professor E. H. Rennie, Angas Professor of Chemistry in the University of Adelaide, is chairman of the South Australian Committee of the Institute of Science and Industry. He displayed keen interest in the movement for the establishment of the Institute, and, notwithstanding the exactions of his professorial duties, has devoted a great deal of time during his association with the Federal organization to the promotion of scientific research. At the present time, he is engaged upon the investigation of Xanthorrhœa Resin, more widely known as Grass Tree Gum. His labours in the field of organic chemistry have earned for him a high reputation, and he has contributed several papers to the *Journal of the Chemical Society of London*, dealing principally with Australian products, such, for instance, as "The Sweet Principle of Smilax Glycyphylla," "The Colouring Matter of Drosena Whittakeri," and "The Colouring Matter of Lomatia Ilicifolia."

A son of Mr. Edward C. Rennie, late Auditor-General of New South Wales, Professor Rennie was born in Sydney. Educated at the Fort-street Public School, and the Sydney Grammar School, he proceeded to the Sydney University, where, in 1870, he graduated B.A. He obtained the degree of M.A. six years later. For a few years, he was a master at the Sydney Grammar School; and later Science Master at the Brisbane Grammar School. In order to pursue his studies in chemistry, he proceeded to London in 1877, and worked at the Royal College of Science, South Kensington, under Professor Frankland. Four years later, he graduated D.Sc. (London). For a brief period he acted as Demonstrator at the Royal College of Science, and later was for two years assistant to Dr. C. R. Alder Wright, at St. Mary's Hospital. He was also associated with Professor H. E. Armstrong, at Finsbury Technical College.

Shortly after his return to Australia in 1882, he accepted the position of Angas Professor of Chemistry at the University of Adelaide. He soon became absorbed in the affairs of the University, and was elected to the Council in 1889. Resigning that position in 1898, in order to re-visit England, he was re-elected again in 1913, and has retained a seat on the Council up to the present time. Last year, Professor Rennie was elected Deputy Vice-Chancellor during the absence of the Vice-Chancellor in England.

REVIEWS.

Mathematics for Engineers, Part II., by W. N. Rose, B.Sc. Pp. xiv., 419. London, Chapman and Hall Ltd. 1920. Published price, 13s. 6d. This book is the second volume of a comprehensive and practical treatise on the subject of mathematics for engineers. The first part dealt with Mensuration, Graphs, Advanced Algebra, Plane Trigonometry, Plotting of Curves, &c. With the exception of Chapters on Spherical Trigonometry and Mathematical Probability, the second part is devoted to the study of the calculus, both differential and integral. Though the treatise is based upon algebraic principles, much attention has been paid by the author to graphic interpretation. Thus from the commencement the connexion between the rate of change of a quantity and the slope of a curve is clearly demonstrated, and this correlation of the algebraic and graphic methods is continued through all the stages of the development of the subject.

In Chapter 1, the conception of "limiting values," which was mentioned briefly in Part I. of the book, is further discussed, and two methods of graphic differentiation are given. The various rules for the differentiation of both algebraic and trigonometrical functions are explained in detail in Chapter 2, while Chapter 3 explains the rules for the differentiation of a function, the product of functions, &c., and furnishes an introduction to partial differentiation. Interesting and valuable examples of the practical applications of differentiation are given in Chapter 4, and special attention is paid to the determination of maximum and minimum values. The use of Taylor's Theorem in cases of interpolation from steam tables is demonstrated.

Chapters 5 and 6 contain the rules required for the integration of functions occurring in engineering theory and practice. At this stage also the reduction formulæ are introduced, and mention is made of the Gamma function and its uses. Examples of the application of the rules of integration are given in Chapter 7, and special features of this Chapter are the graphic method for fixing the position of the centroid vertical, and the evaluation of moments of inertia. The following Chapter deals with the utility of polar co-ordinates, and illustrations are given of their practical value by the inclusion of examples on the candle-powers of lamps and the employment of the Rousseau diagram to find the mean spherical candle-power. The methods of solution of common types of differential equations are lucidly explained, and Chapter 10, with its applications of the calculus to problems encountered in the study of thermodynamics, strength of materials, applied mechanics, electricity and hydraulics, provides further illustration of the need of a sound knowledge of the subject to the engineer desirous of equipping himself at all points.

The two volumes of *Mathematics for Engineers* form a comprehensive and valuable practical treatise on the whole subject, and will prove of service both as a reference work to practising engineers and as a text-book for engineering students. The information given in the book is clearly set out and lucidly explained, and the subject-matter has been so chosen, and the examples so applied to practical problems as to greatly enhance the value of the work.

Manual of the Chemical Analyses of Rocks.—Henry S. Washington, Ph.D. 3rd Edition (1919), pp. xii. and 271. John Wiley & Sons, Inc., New York.

This is a revised and enlarged edition (third), the first and second appearing in 1904 and 1910 respectively. It is obvious, therefore, that there was great scope for thorough revision and additions of new methods, descriptions of new equipment and new literature. The author thought it wiser to adhere to well-known and reliable methods rather than supplant them by others more recently proposed but not yet of proved value. In the first edition an endeavour was made to give the minutiæ of manipulation and precautions to be observed in undertaking, *e.g.*, the analysis of a silicate rock, and this idea has been further extended in the present edition, and more stress has been laid on the sources of error, both in operations and in method. To a student working alone this is invaluable. Too often do we consult text-books on method, only to find that they all omit the minute details that we wish to find, and what other workers on the same subject must meet.

It is possible with this book to follow out carefully the analysis of an ordinary silicate rock. To the expert analyst on rock work, therefore, much of the work may seem superfluous, but to the lone worker and to the student seeking to become acquainted with such work, the discussions, exact methods, difficulties, and the sources of error are of inestimable value. The author's position on the staff of the Geophysical Laboratory of the Carnegie Institution, under Dr. Arthur L. Day, the Director, and the adoption of the general methods of the United States Geological Survey, are a sufficient guarantee of the value of the methods. One hundred and eight pages (Parts I. to V.) cover the general methods of working, such as the apparatus, the sampling, the operations of decomposition, precipitation, filtration and washing, drying, ignition, and titration. The metric system is used, and an extremely useful section is that on Reagents, pages 45 to 56. We are in hearty agreement with the author's recommendation for a preliminary microscopical examination, and would like to see this very much extended, owing to the ease, cheapness, and quickness with which many microscopic qualitative analyses can be made. The use of polarized light, of crystallography, refractive indices, and microscopical chemical methods is so valuable, that the quantitative analyst might often be saved very much tedious work of a less accurate character. Part V. covers the main part of the actual determinations, and here the discussions on the source of errors are most valuable. The appendices include a typical analysis, factors for calculation, and a selected list of authoritative works, with a good index of references. The usual index of subjects appears to be very well done (pp. 235 to 271). The book forms a valuable addition to the analytical chemist's library. Price, 11s. 6d. net.

Chemists' Manual of Non-ferrous Alloys, by James R. Downie, F.C.S., pp. 168, with 33 illustrations. E. & F. N. Spon Ltd., 57 Haymarket, London. Price: 10s. net. Among other positions which he has held, the author was chemist to the Great Cobar Mining Co., New South Wales, and the processes which he describes have, therefore, stood the test of actual practice. Apart from rare

metals, they cover any of the alloys usually manufactured in non-ferrous alloy factories.* There are several chapters of introductory matter for the benefit of beginners, such as laboratory and fittings, chemicals, &c., but the main value of the work lies in the clear, concise explanation of the processes, which must form a handy reference for chemists professionally interested in the manufacture and use of alloys of this class. In Chapter XII. the results of typical analyses are given, and the author explains that these, in most cases, have been obtained by the processes given in the volume; although, in a few instances, they have been obtained from standard text-books.

Alcohol: Its Production, Properties, Chemistry, and Industrial Applications, by Charles Simmonds, B.Sc., pp. xx + 574. London, Macmillan & Co. Ltd., 1919. This work deals with the materials used for the production of alcohol, both by fermentation and by synthetic processes; the biochemical agents involved; methods of distillation and rectification; the conversion of cellulose substances into alcohol; and the analytical chemistry of methyl and ethyl alcohol. In addition, chapters are devoted to alcoholometry, and industrial alcohol, including regulations for denaturation and the industrial uses of alcohol. The author also treats of various spirituous beverages, their origin, nature, and chemical examination, and concludes with a brief statement of what is definitely known concerning the physiological effects of alcohol. It will be seen, therefore, that the book is a comprehensive treatise dealing with practically all phases of the production and use of alcohol. The question of alcohol as a fuel, especially for internal combustion engines, is dealt with, and the author points out that this question is becoming a very important one. Some details are given of the results of the special investigations made in America, and by the Commonwealth Institute of Science and Industry, to determine the relative advantages of alcohol as a fuel, compared with petrol. Attention is directed to the greater efficiency of alcohol, and to its other advantages, compared with petrol. As regards the difficulty of starting from cold on alcohol, the author had not, apparently, at the time when the book was compiled, been informed of the simple and effective method which has been devised by the Commonwealth Institute of Science and Industry for overcoming this difficulty. Internal combustion engines have been perfected for use with petrol, but when a similar amount of research has been directed to the use of alcohol, this liquid may be found even more suitable than petrol. Attention is directed to the suggestion that the distillation of power-alcohol should be undertaken in England on a co-operative basis, whereby a central distillery would serve a number of farms, much on the same lines as with co-operative creameries; but such a system would obviously mean a considerable modification of existing Excise regulations for distillery supervision. Some interesting information is given regarding the production of alcohol from saw-mill waste, and the author considers that the facts indicate that ultimate commercial success in this direction is assured. At first, it was thought that every saw-mill represented a possible location for an alcohol plant, but it was soon found that there were very few mills at which the conditions were altogether favorable for establishing a distillery. The "life" of the lumbering operations may be uncertain, the water supply deficient, labour facilities unfavorable, and so on. Wood-waste is bulky, and costly to handle and transport, so that it must be treated at the place where it is produced. It is, therefore, suggested that the saw-mills should produce the sugar solution from the waste wood, but should not ferment or distil it. The syrup could then be conveyed to large scale distilleries. Alcohol from the waste liquors in the manufacture of sulphite wood-pulp is being produced in considerable quantities

in Sweden. Synthetic alcohol from acetylene has been developed in Germany and Switzerland during the war; but it remains to be seen whether the industry will be permanently established. Mr. Simmonds is one of the senior analysts in the Laboratory of the Government Chemist, and, by reason of his experience, is well qualified for the compilation of the book, which is well arranged and printed, while the information is lucidly presented and up-to-date.

SOME PUBLICATIONS RECEIVED.

Nitrogen Products Committee, Final Report.—This Committee was appointed in June, 1916, as a committee of the Advisory Panel of the Munitions Inventions Department to consider, generally, what steps could with advantage be taken to conserve and increase the national resources in nitrogen-bearing compounds, and to limit their wastage and to examine the relative advantages of the various methods for the fixation of atmospheric nitrogen.

Agricultural Gazette of New South Wales (March).—The articles include a paper by H. Wenholz, B.Sc., on the factors making for soil improvement for maize, and deals particularly with manures and fertilizers. F. B. Guthrie, A. A. Ramsay, R. M. Petrie, and F. J. Stokes have prepared a list of fertilizers obtainable in New South Wales, together with their composition. "The composition of various lead arsenates" is contributed by A. A. Ramsay.

The Journal of the Department of Agriculture of Victoria (March).—The principal articles are "The Goroke Crop and Fallow Competitions," by H. A. Mullet, B.Ag.Sc.; "Agriculture in Denmark," by R. T. McKenzie; "Pear Growing in Victoria," by E. Wallis, and "Some French Sweet Wines," by F. de Castella.

Journal of the American Society of Heating and Ventilating Engineers (January).—This issue forms the initial number in the new monthly plan of publication authorized by the society. F. W. Staley, writing on "Oil Fuel," sets out the advantages of liquid fuel. E. R. Knowles, in an article on "Pulverized Fuel," points out that, although great improvements have been made in the methods of utilizing coal as a fuel—from the first crude use in varying sized lumps, hand fired in crude and inefficient form of boilers, to the present-day practice of using finely-graded coal, mechanically fired in the most efficient type of boilers—yet notwithstanding all this advancement present boiler practice with the best equipment wastes from 25 to 35 per cent. of the heat value of the fuel consumed. Diagrams showing the various types of furnaces are given, and various combustion problems are dealt with. An advance in air conditions in school buildings is described by E. S. Hallett. To sum up the results of a year's tests with ozone, the following facts are indicated:—Ozone destroys all odours resulting from the respiration, bodies and clothing of the children. It produces a mild exhilaration resembling that of a sea breeze or the air on a morning after a thunderstorm. It removes smells from the building due to lodgment of dust in ducts and the like. It destroys toilet room odours. When used in proper concentration for ventilation it has no odour itself. It reduces weight in persons corpulent from inactivity. It appears from limited data to be a preventive of influenza. It undoubtedly is of great value in the treatment of influenza and pneumonia, as demonstrated in the influenza hospital in St. Louis last year. To this should be added the evidence adduced by the medical authorities of France that ozone increases greatly the oxyhæmoglobin of the blood, thereby increasing the oxygen-

carrying capacity of it. This in turn cures anæmic persons. The introduction of ozone in ventilation would probably remove the necessity for open-air schools now common in most cities. "Fuel Oil Equipment," by John P. Leask; "Oil Fuel *v.* Coal," by D. M. Myers; "Four Years' Experience in prevention of Corrosion of Pipe," by F. N. Speller and W. H. Walker; "The Magazine Feed Boiler and Fuel Conservation," by Chas. F. Newport; and "Heat Losses from Direct Radiation," by J. R. Allen are other articles.

The Journal of the Franklin Institute (*February*) contains an article on Sound Ranging, by Professor A. Trowbridge, who was in technical charge of Sound and Flash Ranging in the A.E.F., in which he describes the principles of the science and the work done on the Western Front. The relative merits of Monocular and Binocular Field Glasses are discussed by E. P. Hyde, P. W. Cobb, H. M. Johnson, and W. Weniger. "The Absorption of Nutrients and Allied Phenomena in the Pitchers of the Sarraceniaceæ" is contributed by J. S. Hepburn, E. Q., St. John, and F. M. Jones. "Brannerite, a new Uranium Mineral," is described by F. L. Hess, A. B. and R. C. Wells, Ph.D.

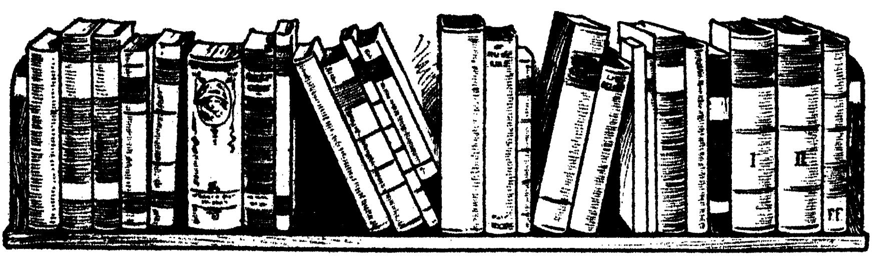
Journal of Agricultural Research, published by authority of the Secretary of Agriculture, United States of America, with the co-operation of the Association of Land Grant Colleges (February). Contents: "European Fruit Fly in North America," by J. M. Aldrich, "Lepidoptera at Light Traps," by W. B. Turner, and "Life History of Enbiomyia calosomæ, a Tachinid Parasite of Calasoma Beetles."

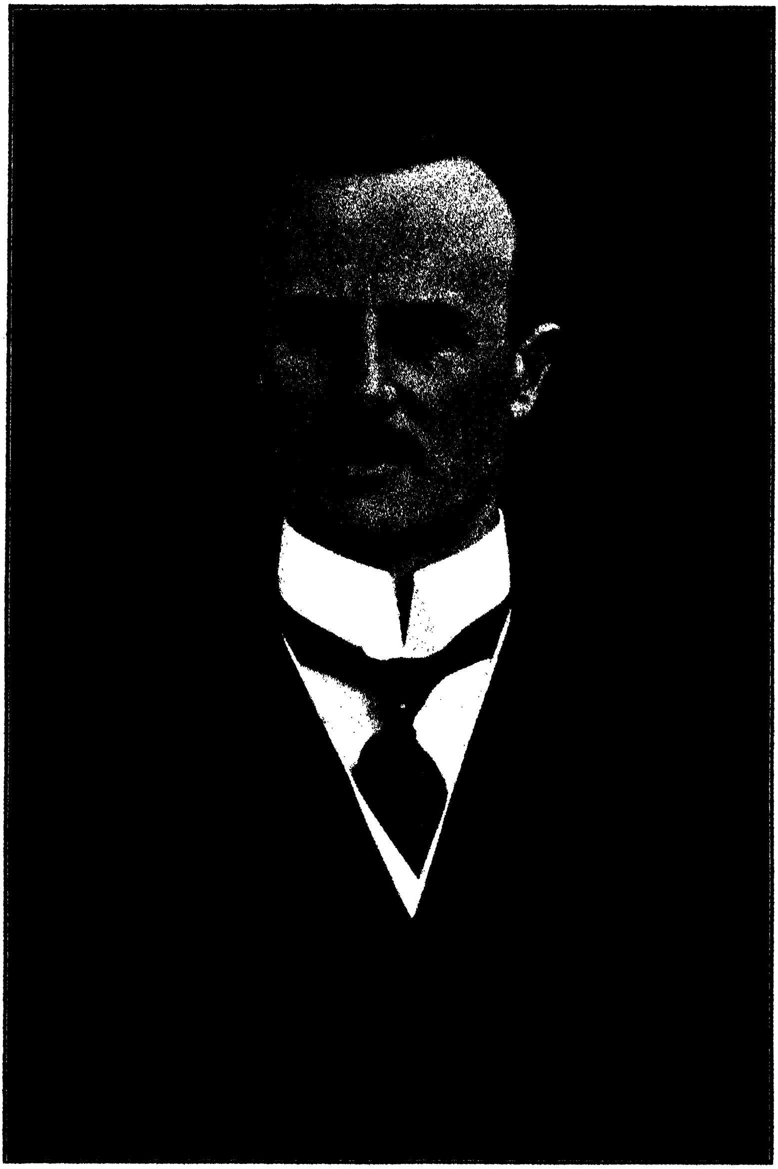
The Anatomical Record (*January*) from the Wistar Institute of Anatomy and Biology.

The American Journal of Anatomy (*January*) from the Wistar Institute of Anatomy and Biology.

Select list of works relating to City Planning and Allied Subjects from the New York Public Library.

A Critical Revision of the Genus Eucalyptus, by J. H. Maiden, I.S.O., F.R.S., F.L.S., Government Botanist, New South Wales. Vol. IV., parts 9 and 10. Price 2s. 6d. each. Government Printer, Sydney.





PROFESSOR J. DOUGLAS STEWART.

Chair of Veterinary Science, University of Sydney, and member of the Executive Committee, Institute of Science and Industry.

(For Biographical Notes, see page 317).

SCIENCE AND INDUSTRY.

VOL. 2.] MAY, 1920. [No. 5.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

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Articles may be freely reprinted, provided due acknowledgment is made of their source.

Industrial Progress and Scientific Research.

THE first bulletin published by the National Research Council of the United States of America comprises a series of short statements upon the national importance of scientific and industrial research. From a country which, perhaps with the exception of Germany, has done more than any other to encourage and handsomely subsidize research into industrial problems, the emphasis which is laid upon the necessity of largely increased effort in this direction cannot be idly ignored by countries which have either to make or retain for themselves a place among the leading nations of the world. The war is over, and the international competitions of peace have been resumed. The object of this publication, prepared by leaders in the scientific and industrial world of America, is to stimulate their nation to further action. They clearly realize that the prizes in the race for industrial and commercial leadership must inevitably go to the nation which makes the best use of its scientific forces.

One aspect or another of this vital problem is discussed by men who, by reason of their close association with science and with industry, are best qualified to express an opinion. The one fact common to all, however, is the close connexion in recent years between industrial progress and industrial research. Large industrial enterprises have developed mainly through the organization of their scientific departments.

At the same time, the extraordinary results accomplished in agriculture of recent years have been brought about by State scientific investigation and co-operation.

A contribution by Mr. Henry S. Pritchett, President of the Carnegie Foundation for the Advancement of Teaching, deals with the function of scientific research in a modern state. "The world," he writes, "still conceives of scientific investigators in much the same light as the old-time prospectors for the precious metals—each individual sinking his shaft here or there, as chance or inclination may carry him. Of the great number so engaged, a very few will strike veins of pure gold, a large number will obtain one that will at least repay the labour and cost involved in their adventure, but the great majority will sink holes in barren and fruitless soil." But, as he points out, the prosecution of research to-day is upon an entirely different basis. Research, to be effective, must be organized and co-operative. The scientific worker must know what has gone before, and what his contemporaries and co-workers are doing, or he will waste his life in duplicating effort.

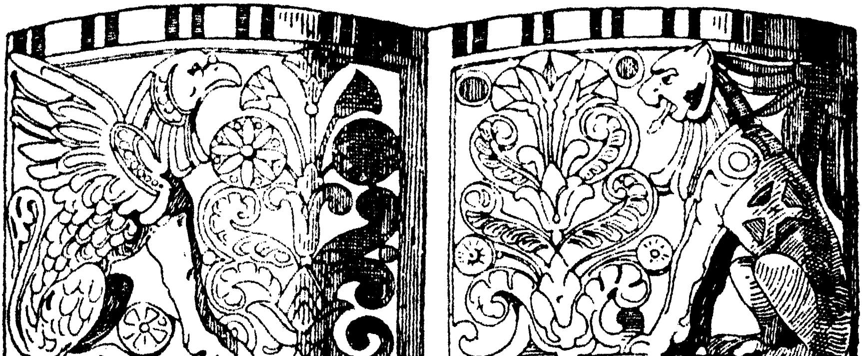
The great German industrial research establishment at Charlottenburg and Grosslichterfelde is mentioned appreciatively by one or more writers, and is instanced by Mr. Pritchett as an illustration that the research men of a nation should not be isolated individuals, but a co-operating army. In this vast establishment, covering many acres, are brought together research men from every field of science, working together in the solution of problems arising in the industries. "As a result of this co-operation, the German manufacturer may take to this great research laboratory any problem of scientific industry."

In the United States of America, concern is expressed, not so much for the large industries, which have developed research departments at the commencement of their industrial enterprise, but for small and novel industries, which are unable to carry the burden of a highly organized research department. "Unless something is done," states Mr. Theodore N. Vail, the President of the American Telephone and Telegraph Company, "to meet the needs of such industrial establishments, a type of enterprise which has done much to advance civilization and to promote industrial progress will tend to disappear because of the impossibility of competing with larger and well-established industrial organizations."

Mr. Ambrose Swasey, President of the Warner and Swasey Company, credits the great advances in industry chiefly to scientific research, and to the work of the technician, which has made practicable and applicable the deductions of the scientist. Mr. A. W. Mellon, President of the Mellon National Bank of Pittsburg, urges an understanding on the part of industrialists as to the requirements of industrial research. In his opinion, the fundamental differences between

pure research and industrial research are traceable to the differences in the poise and personality of the representatives of each type of scientific investigation. "Success in genuine industrial research presupposes all the qualities which are applicable to success in pure science, and, in addition, other qualities, executive and personal, more or less unessential in the pure research laboratory. At this point enters the real value of a system of co-operation between science and industry; the industrialist is aided by being taught the correct methods to follow, and by guidance in the selection of the proper type of research men to carry on his work."

E. N. R.



EDITORIAL

IMPORTATION OF EX-ENEMY PUBLICATIONS.

The Institute of Science and Industry lately approached the Government with the request that the embargo at present placed on the importation of scientific and technical publications of ex-enemy countries be removed. The Cabinet decided that scientific literature may be imported subject to a list of the publications desired being submitted to and approved by the Minister for Trade and Customs. This list was sent to the Department of Trade and Customs, and the Department has now replied permitting the importation of all publications in the list. The list comprises 164 periodicals and the publications of 132 societies and institutions. It includes all the periodicals which were known to have been received in the Commonwealth before the war. A copy of the list has been sent to the principal learned societies and institutions in Australia, with a request for suggestions and additions for a supplementary list for which it is proposed to seek unfettered importation. It has been found practically impossible to furnish a list of books, catalogues, and publications of international scientific congresses, the importation of which will only be permitted provided details are supplied in each case.

ARTIFICIAL COAL.

The Norwegian engineer Strehlenert has discovered a process by which coal can be and is now being produced from the waste waters of cellulose factories. The manufacture of wood pulp is, as is well known, the staple industry in Norway, so that the manufacture of coal as a by-product, though it may sound incredible, promises to be a new and potent source of the world's fuel supply. We have known for some time that these waste waters are of some fuel value, since alcohol has been manufactured from them during the shortage of petrol as motor spirit, for internal-combustion engines during the war. These waters, which at one time were allowed to pollute the rivers, contain valuable organic matter. The process of converting them into coal is as follows:—The free sulphurous acid in these liquids can be oxidized into sulphuric acid, and under high pressure this acid will decompose the ligninsulpho-salts which are also contained in the waters, so that for every ton of wood pulp 540 to 900 kilos of coal can be produced, which, moreover, contain only 4 to 5 per cent. of ash, whereas ordinary steam coal frequently contains from 10 to 20 per cent. This artificial coal has a heating value of 6,800 units. A wood-pulp factory with an annual capacity of 25,000 tons can thus produce as a by-product an annual

22,000 tons of coal. According to the information given by the inventor, the cost of the necessary plant for such an installation is about 600,000 kroner (£33,375); and the cost of producing one ton of coal is estimated to be, in normal times, between 5 and 6 kroner (5s. 7d. and 6s. 9d.), while at the present day it is about 10 kroner (11s. 1½d.). The artificial coal so produced may either be burned in its slightly moist state, as produced, or it may be dried and used as pulverized fuel. The first factory of this kind has recently been set to work in Greaker, near Frederikstad.—*Engineering and Industrial Management.*

RESEARCH WORK IN MINING INDUSTRY.

The Federal Bureau of Mines in the United States of America is now conducting eleven mining experimental stations. One of these, *i.e.,* at Columbus, Ohio, situated at a clayworking centre, is employed mostly on ceramic problems. In America there are about 4,000 firms manufacturing clay products, including brick, tile, sewer pipe, conduits, hollow blocks, architectural terra cotta, porcelain, earthenware, china and art pottery. The amount invested in these industries is approximately £75,000,000, and the value of the products exceeds £40,000,000 annually. The station at Bartlesville, Okla., is investigating problems that arise in the proper utilization of oil and gas resources, such as elimination of waste of oil and natural gas, improvements in drilling and casing wells, prevention of water troubles at wells, and of waste in storing and refining petroleum, and the recovery of gasoline from natural gas. What the Bureau of Mines has done for the great coal-mining industry, chiefly through investigations at the experiment station at Pittsburg, Pa., has been published in numerous reports issued by the Bureau. Some of the more important accomplishments have been the development and introduction of permissible explosives for use in gaseous mines, the training of thousands of coal miners in mine-rescue and the first-aid work, and the conducting of combustion investigations, aimed at increased efficiency in the burning of coal, and the effective utilization of our vast deposits of lignite and low-grade coal. The Salt Lake City station has devised novel methods of treating certain low-grade and complex ores of lead and zinc. These methods show a large saving of metal over methods hitherto employed, and have made available ores which other methods could not treat profitably. The Seattle station is busy with the treatment of the low-grade ores of the north-west, and the mining and utilization of the coals of the Pacific States; the Tucson station is working on the beneficiation of low-grade copper ores; and the Berkeley station has shown how losses may be reduced at quicksilver plants and how methods at those plants can be improved. In the conduct of these investigations the Bureau seeks, and is obtaining, the co-operation of the mine operators. At more than a dozen mills in the west, engineers from the stations are working directly with the mill men on various problems, and the results they already have obtained more than warrant the existence of the stations. Success in solving one problem may easily be worth millions to the country. Mining men are using these stations more and more freely, as they realize that the Government maintains these stations to help them, and that the difficulties of the operators, both large and small, receive sympathetic consideration and such aid as the stations can give.

U.S.A. NATIONAL RESEARCH COUNCIL—GIFT OF £1,000,000.

The National Research Council of America has received a gift of £1,000,000 from the Carnegie Corporation of New York, and it is proposed to expend a portion of the money in erecting at Washington a home for the Council. In announcing this gift the report from the Council says:—This impressive gift is a fitting supplement to Mr. Carnegie's great contributions to science and industry. The Council is a democratic organization, based upon some forty of the great scientific and engineering societies of the country, which elect delegates to its constituent divisions. It is not supported or controlled by the Government, differing in this respect from other similar organizations established since the beginning of the war in England, Italy, Japan, Canada, and Australia. It intends, if possible, to achieve in a democracy, and by democratic methods, the great scientific results which the Germans achieved by autocratic methods in an autocracy, while avoiding the obnoxious features of the autocratic *régime*. The Council was organized in 1916 as a measure of national preparedness, and its efforts during the war were mostly confined to assisting the Government in the solution of pressing war-time problems involving scientific investigation. Re-organized since the war on a peace-time footing, it is now attempting to stimulate and promote scientific research in agriculture, medicine, and industry, and in every field of pure science. The war afforded a convincing demonstration of the dependence of modern nations upon scientific achievement, and nothing is more certain than that the United States will ultimately fall behind in its competition with the other great peoples of the world unless there be persistent and energetic effort expended to foster scientific discovery.

JAPAN'S CHEMICAL INDUSTRY.

It is widely known, in a general way, that the war has stimulated industrial development in Japan in a most remarkable manner. The extent and the nature of her industrial achievements, however, are not fully realized. In the *Journal of Industrial and Engineering Chemistry*, Vol. 12, No. 28, an article by Mr. O. P. Hopkins deals with the efforts of Japan towards the development of her chemical industry, and he clearly shows that sound progress has been made in many lines. Important features of the review deal with the development of a coal-tar industry, the production of alkalies for the paper, glass, textile, and soap industries, progress in metal refining, and the greatest possible utilization of water power in electro-chemical processes. The manufacture of iodine and potash from kelp, of glycerine, paints, fertilizers, the tanning of skins and hides, and many minor lines have also been pushed energetically. The statistics of production and trade indicate the magnitude of many new industries. In 1915 an Act was passed to subsidize one company for the manufacture of dyestuffs, and under this Act was organized the Japan Dyestuff Manufacturing Joint Stock Company, with a capital of £800,000. The Government guaranteed dividends of 8 per cent., and there was a disposition at first, on the part of unprotected manufacturers, to fear the competition from this firm, and resent the action of the Government. By the middle of 1918

there were 100 factories in existence, exclusive of small concerns manufacturing inferior goods, with a total capitalization of £1,500,000. Imports of aniline dyes into Japan had fallen from 9,700,000 lbs. in 1913 to 2,500,000 in 1918. Artificial indigo, of which, in 1913, over 2,000,000 lbs. was imported, ceased to be brought in from abroad. Exports of glass and glassware jumped from a value of £300,000 in 1913 to £1,400,000 in 1918. In paints exports have increased from less than half a million to more than 15,000,000 lbs. since the war started. Exports of soap and glycerine, in four years, moved from £150,000 annually to nearly £500,000 in five years. Soda and bleaching powder and sulphur are other important items whose production have undergone enormous increase since the commencement of the war.

JAPANESE IRON INDUSTRY.

The iron industry in Japan made steady development during the war. In 1913, just before the war, the volume of pig-iron produced in Japan totalled 240,000 tons, and steel 250,000 tons. But pig-iron to be turned out in Japan during 1919 and 1920 is expected to amount to 1,200,000 tons, *i.e.*, 900,000 tons from Japan proper, 80,000 tons from Korea, and 240,000 tons from Manchuria. It is also expected, says the *Herald* of Asia, that pig-iron and steel to be demanded during 1920 will reach 430,000 tons and 1,300,000 tons respectively, but iron foundries in Japan are now able to meet all the demand excepting special kinds of steel and iron. Particulars of iron foundries in Japan, and their capacity, are as follows:—Government Foundry (Yawata), 400,000 tons; Hokkaido (Wanishi), 150,000 tons; Toyo (Tobata), 150,000 tons; Tanaka Kozan (Kamaishi), 120.000 tons; Nippon Sentetsu (Kokura), 10,000 tons; Nippon Sentetsu (Kurosaki), 15.000 tons; Tokyo Sentetsu, 100,000 tons; Sanyo Sentetsu (Otake), 8,000 tons; Senjin Sentetsu, 10,000 tons; Mitsubishi (Kyomipo, Korea), 80,000 tons; Pen-Hai-hu (Manchuria), 60,000 tons; Anshanchan (Manchuria), 180.000 tons; others, 27,000 tons. Total, 1.220,000 tons.

AEROPLANES ASSIST FOREST DEVELOPMENT.

That aeroplanes will in the near future play an important part in the development of forest areas is certain. In this issue of *Science and Industry*, Mr. Owen Jones, chairman of the Forestry Commission, suggests a means of co-operation between the military authorities and other Government Departments for the employment of aeroplanes for photographic survey work, in a discussion of a scheme submitted to the Institute by Mr. H. E. S. Melbourne, of South Australia. In the United States already one of the peace-time uses for aircraft is for forest fire or patrol. Mr. Clive Leavitt, in a bulletin published by the Commission of Conservation, Ottawa, Canada, points out that, in the United States, experiments have been carried out in some of the Western States, under an arrangement between the Air Service and the Forest Service. These trials produced such promising results in the prompt discovery and reporting of forest fires that a greatly-enlarged programme for the current year is under consideration. Col. H. H. Arnold, of the United States Air Service, has presented to his Government a report

recommending that an air patrol be inaugurated to cover all lands—Government, State, and private—in Western Wyoming, Montana, Idaho, Washington, Oregon, and California. This would require five complete observation squadrons of eighteen planes each, or ninety planes, with pilots, observers, and complete squadron equipment, each plane to be equipped with radio sets for sending location of fires discovered, and two planes in each squadron, to be equipped with wireless telephone sets and cameras. Operators for wireless stations at bases and sub-bases, and the establishment of pigeon lofts at bases and sub-bases would also be required. A resolution of the Western Forestry and Conservation Association points out that the use of airplanes to protect the nation's forests gives opportunity for the training of pilots and observers, while serving a purpose, which, in itself, fully justifies the expense involved. The experiments along this line in Canada have been comparatively limited, being confined, during the past summer, to two seaplanes loaned by the Dominion Government to the St. Maurice Forest Protective Association. The Quebec Government has also co-operated by aiding the work with a cash grant. In Canada, the whole question of the Dominion Government's programme of air services is under consideration by the Air Board. As the possibilities and limitations of peace-time uses of aircraft have been by no means fully demonstrated, it is logical that the Dominion Government should take the lead, in co-operation with the provinces, as to services of an essentially public character. Experimentation and demonstration are essential if this wonderful new development, resulting largely from the war, is to play its full part in the peace-time development of Canada.

The Work and Present Position of the Temporary Institute.

I.—Initial Action.

The first steps towards the formation of a Commonwealth Institute of Science and Industry were taken in January, 1916, when the Prime Minister convened a Conference in Melbourne to consider the matter. At this Conference there were present the Ministers of Agriculture for Victoria, South Australia, and Queensland; representatives of the State Universities and of the Inter-State Commission; and the Presidents of the Associated Chambers of Commerce of Australia and the Associated Chambers of Manufactures of Australia. In addition, other leading men engaged in scientific and industrial pursuits attended from each State. The Conference was thus thoroughly representative of all interests concerned.

At this Conference a scheme was prepared for the establishment of a permanent Institute of Science and Industry, and for the creation of a temporary Advisory Council to carry out certain initial work pending the establishment of the permanent Institute. It was anticipated that the permanent Institute would be established by Act of Parliament shortly, and probably soon after the return of the Prime Minister from England in 1916, and it was solely on this understanding that the proposals for the creation of a mere temporary body to pave the way for the permanent organization were adopted and that the members of the Advisory Council agreed to undertake the preparatory work.

II.—Establishment of Temporary Advisory Council.

The temporary Advisory Council was accordingly appointed by the Government, and held its first meeting in April, 1916. At this meeting the Ministers for Agriculture for Victoria, Queensland, and South Australia were present. The New South Wales Minister for Agriculture was represented by the Under-Secretary of his Department, but the Ministers for Agriculture for Western Australia and Tasmania were unable to be represented. Representatives of Science and Industry from all the States were also present. An Executive Committee was appointed, and State Committees were established in each State.

The temporary body was designed to prepare the ground for the proposed permanent Institute and in particular to—

(*a*) consider and initiate scientific research in connexion with or for the promotion of primary or secondary industries in the Commonwealth, and

(*b*) collect industrial scientific information and to form a Bureau for its dissemination amongst those engaged in industry.

The Executive Committee having made preliminary arrangements for carrying on the temporary work, a meeting of the whole Council, representing all the States, was held in August, 1916, when the scheme of work was discussed and approved. A further meeting of the whole Advisory Council was held in July, 1917, when the scheme for the work and organization of the permanent Institute formulated by the original Conference of January, 1916, was elaborated and approved unanimously.

III.—Initial Work of Temporary Body.

The work of the temporary organization has been carried out mainly by the Executive Committee and the State Committees. By the middle of 1917 the temporary body had completed the work for which it was specifically appointed, and informed the Commonwealth Government accordingly, and urged it to establish the permanent Institute forthwith. The temporary body, however, at the request of the Government, has continued in existence, and for over three years has carried out work of a permanent nature, for which its scheme of organization, working mainly through honorary Committees, is not suitable, and for which its powers and financial resources have been quite inadequate.

In order to prepare the way for the permanent Institute a great deal of preliminary work had to be done. The first work was the taking of a problem and industrial census to ascertain what are the main scientific and technical problems affecting industries in each State, and which industries are most likely to be benefited and developed as the result of industrial research. Then, as it was proposed to utilize as far as practicable existing laboratories and institutions and to avoid overlapping and duplication of effort, a complete register was compiled of the *personnel* and facilities available for research work at laboratories throughout Australia. Registers were also compiled of research work in progress at these laboratories and at the State Government Experimental Farms. As the activities of the future permanent Institute would necessarily depend very largely on the number of properly-trained scientific investigators available in Australia, a record was made of the existing facilities for training such men and of the supply available.

Another important matter to which considerable attention was given was the establishment of co-operative arrangements for carrying on research work with State Government Scientific and Technical Departments, Scientific and Technical Societies and Associations, and other authorities. Though it was found at first that there was some disinclination to co-operate on the part of persons who had not been informed as to the aims and policy of the Institute, all such opposition has now disappeared, and the State Government Departments and scientific and technical societies are now all co-operating with the Institute and supporting its work.

In accordance with the functions which it was established to perform, the temporary Institute initiated a number of research investigations. Though it was contemplated that any work initiated in this way would be handed over at an early date to the permanent Institute, a number of the investigations have, as will appear below, been already completed.

IV.—Research Work.

Owing to the fact that the temporary Institute has no laboratories or research staff or apparatus of its own, it had to arrange as best it could for investigations to be carried out at existing laboratories and institutions in Australia. The plan of action in each case has been to gather and study all available information in the form of existing reports, &c., and to take verbal evidence, where possible, from men known to be authorities on the special question, and then to appoint a small Special Committee of experts either to give further advice and information with a view to future research by the permanent Institute, or where practicable, to carry out actual experimental work.

These Special Committees consist in each case of the best experts available, both on the scientific and industrial side, whether members of the temporary Advisory Council or not. In this way it has been possible to obtain the advice and assistance on any particular problem of the leading experts throughout the Commonwealth. Particular attention has been paid to secure adequate representation on these Committees of manufacturers and other persons engaged in industry, and much benefit has been derived from this combination of the scientific and industrial points of view. The members of these Committees act in a purely honorary capacity, and it is only by reason of their enthusiasm and self-sacrifice that the temporary organization has been able to carry on its work. It is anticipated that the permanent Institute will have greater powers, and will be enabled by Act of Parliament to build and equip laboratories and appoint its own scientific staff for the conduct of necessary researches, while, of course, it will continue to avail itself also of all existing facilities and assistance.

V.—Work Accomplished and in Progress.

A *précis* of the more important work carried out and in progress is given in the following paragraphs:—

A.—*Agricultural and Pastoral Industries.*

1. *General.*—The loss caused to the agricultural and pastoral industries of Australia, and the secondary industries dependent on them, by diseases, pests, and parasites amounts to millions of pounds per annum. Nearly all the most serious pests in Australia have been introduced from other countries, but now that many of them have spread over the whole or a great part of Australia, the work of eradication will be costly and take a number of years. Before an efficient campaign against any of these pests can be organized, it is necessary that present knowledge should be supplemented by a considerable amount of scientific investigation, and by the co-ordination of effort in the various States. For example, it is essential that the life-histories of the pests should be more fully understood. The temporary Institute has carried out a considerable amount of work in this connexion, but with the resources at its disposal it has not been able to do much in the direction of organized efforts for eradication.

2. *Cattle Tick Pest.*—The cattle tick pest, which annually levies a huge toll on the cattle industry of Australia, has received special attention. Scientific investigations into the life-history of the cattle tick in Australia have been undertaken, and the valuable results which

were thus obtained point to a means of effective control by a system of quarantine. Although this work constitutes a big advance, the temporary Institute has neither the necessary administrative powers nor funds to undertake a campaign for the eradication of the tick. A Conference was, however, held in February, 1918, with the New South Wales and Queensland authorities, and recommendations were made to carry out such a campaign. Another matter which is being investigated by the Institute, in co-operation with both the New South Wales and Queensland Departments of Agriculture, is the determination of the composition and strength of cattle tick dips.

3. *Worm Nodule Disease.*—As regards the worm nodule, the presence of which in cattle in certain areas of Australia constitutes so big a handicap to the beef-export trade, little was known how the disease is transmitted. The Institute has carried out investigations, and has obtained valuable evidence concerning the means by which the disease is transmitted. Experiments will be made next season to determine this point more definitely, so as to ascertain the most likely methods for the effective control of the disease.

4. *Tuberculosis in Stock.*—This is another matter which is being investigated. The first step was to obtain authoritative information from each State as to the prevalence of the disease, the sources of infection, the losses caused, and preventive methods at present in operation. This work has practically been completed, and, as in other cases, was performed gratuitously by leading veterinary officers, pastoralists, and others scientifically and economically interested.

5. *Sheep Blowfly.*—Important investigations on the sheep blowfly pest have been carried out both in New South Wales and Queensland, especially in regard to the utilization of natural parasites which destroy the pupæ of the blowflies. Demonstration work is now going on in New South Wales under a grant made by the Institute. The results so far obtained have been satisfactory, and afford hope that, if the methods adopted are put into general operation, the seriousness of the pest will be very considerably diminished. Further investigational work by the Institute has, to a large extent, been hung up, as the investigations have now reached a stage at which they cannot be efficiently continued unless larger funds are made available for the employment of properly qualified assistants.

6. *White Ant Pest.*—The white ant pest causes great losses in Australia by reason both of the damage done to buildings and to agricultural crops. The Institute has collected from experts information on this matter, and in co-operation with the New South Wales Government is initiating a scheme of investigational work.

7. *Prickly Pear.*—Prickly pear in Australia covers an area of about 23,000,000 acres, which is greater than the total area of cultivated land in the Commonwealth (17,000,000 acres). The pear is spreading at the rate of about 1,000,000 acres annually. In November, 1916, the Institute presented to the Government a scheme of investigational work with a view to the eradication of the pest. The scheme has since been approved by the Commonwealth, New South Wales, and Queensland Governments. It provides for investigations as to the suitability of

insects and fungi known to be inimical to prickly pear. The effect of poisons on the pear has been fully investigated, but chemical poisoning is too expensive, except on agricultural land, which is but a small proportion of the infested area. Various proposals have been made to cope with the pest by mechanical means—by cutting it or rolling it down—but these have not been found practicable. It is believed that the only economical and hopeful method of solving the problem is to find some natural enemy which will destroy the plant, and thus restore the balance of nature. Arrangements have been made to bring the scheme of investigation into operation immediately, the cost being shared by the Commonwealth, New South Wales, and Queensland.

8. *Flax Industry.*—In November, 1917, an Inter-State Conference of agricultural scientists was convened by the Institute, and this has had most important results. In the first place, as a direct result of the discussion on the cultivation of fibre plants in Australia, the Executive Committee obtained from the British Government a guaranteed price for flax. A recommendation was then made to the Government for the establishment of a special Flax Industry Committee. This was done, and the area under flax has already increased from about 400 to 2,000 acres. As soon as there is an assured production from about 10,000 acres, it is highly probable that the establishment of the linen textile industry in Australia will be assured.

9. *Cotton Growing.*—Varieties of cotton seed specially suitable for cultivation in Australia are being introduced by the Institute for experimental purposes. On the recommendation of the Institute the Government has guaranteed a minimum price for cotton cultivated in Australia. It is expected that this will lead to a considerable extension of the area cultivated.

10. *Seed Improvement.*—Considerable loss and inconvenience result in Australia from the absence of any proper classification of cultivated varieties of crops. The Institute has undertaken investigational work in connexion with the nomenclature of cereals, the elimination of undesirable varieties, and the exchange and dissemination of seed samples for research work in the several States. Valuable progress has been made, and already all the leading varieties of wheat have been dealt with.

11. *Native Grasses and Fodder Plants.*—An Inter-State Committee of experts is at work on the question of the collection, propagation, and improvement of the most promising indigenous grasses and fodder plants in Australia. This is of far-reaching importance to the pastoral industry.

12. *Viticultural Problems.*—In co-operation with the Victorian Department of Agriculture and associations of irrigators representing New South Wales, Victoria, and South Australia, important investigational work is being carried out by the Institute regarding viticultural problems, including both methods of cultivation and treatment for insect and fungus pests. The associations recognise the value of scientific research on viticultural problems, and are contributing up to £1,500 a year towards the cost of the work. The Victorian Department of Agriculture is co-operating with the Institute in these investigations.

13. *Castor Beans.*—Valuable results have already been obtained from experimental work on the cultivation of castor beans in Queensland, and it appears likely that this will have practical results of importance. The Queensland Acclimatisation Society is co-operating with the Institute in the work.

14. *Sorghum.*—Systematic experiments are in progress in New South Wales, in co-operation with the State Department of Agriculture, regarding the possibilities of utilizing sorghum as a raw material for the distillation of power-alcohol.

B.—Forest and Vegetable Products.

1. *General.*—The vegetation of Australia is highly peculiar, a great number of the commonest and most widely distributed plants of the continent being quite distinct from those of other countries. Many whole groups of plants, comprising the genus Eucalyptus, which includes most of our forest trees, are entirely Australian. The fact of this high degree of peculiarity in our flora renders it essential that for the full development of the forest and vegetable resources of our continent researches into the products of all our indigenous plants should be conducted. It is not improbable that work of this nature may reveal new oils and drugs of importance to mankind, new sources of dyes and tannin, or timbers specially adaptable to certain particular uses. Most of the drugs, spices, &c., of India and America were discovered and utilized by the natives of those continents before intercourse with Europe opened up a trade in these products. In Australia, however, the natives made very little use of the indigenous plants for such purposes. In the early days of settlement, primitive experiments were made, and the useful properties of some Australian plants discovered. More recently definite chemical researches have been carried out on scientific lines in various States, especially at the Technological Museum, Sydney, and much important information obtained. Nevertheless, the work is still only in its infancy, and there can be no question that further researches of this nature are urgently required. The temporary Institute has already been able to carry out a good deal of preliminary work in this direction. The problem is essentially a national one, and the co-operation of the Forestry Departments of the States has been promised for the establishment of a Forest Products Laboratory.

2. *Paper Pulp.*—Special attention has been given to this question. As a first step, all the available information regarding the pulping qualities of various Australian timbers and grasses was collected, and a considerable amount of further preliminary experimental work was carried out by the Institute. In particular, investigations made in Western Australia for the Institute on the pulping qualities of young Karri timber have given very promising results.

Investigations are now in progress in regard to the pulping qualities of Victorian Mountain Ash, Western Australian Jarrah, Pinus Insignis, and other timbers, and the Forestry Commissioners in practically all the States have agreed to co-operate in this work, and to contribute towards its expense. Investigations of this nature require not only specially trained assistants, but also special laboratory apparatus and plant. The Institute has only recently been able to make a beginning

in obtaining the necessary resources for the work. The newspaper companies in Western Australia are importing and presenting to the Institute an experimental paper-pulping machine, at a cost of £500, and an experimental beater is being loaned to the Institute.

3. *Tanning Materials.*—Although there are several trees in Australia of which the barks are rich in tanning substances, at present we import wattle bark and tanning extracts from other countries. The barks of the trees in question are not used, for the reason that they suffer from certain disabilities, such, for example, as imparting to the leather an undesirable red colour, and no adequate scientific effort has been made to solve the problem. The Institute has carried out experimental work with a view to the utilization of Queensland Mangrove bark as a tanning material, and a process has been devised of getting rid of the objectionable red colour. As a result, tanners in Brisbane are prepared to utilize this bark on a commercial basis. The Institute has also made preliminary investigations as to the utilization of Western Australian Redgum, but has been unable to follow this matter up, as the services of a properly qualified leather chemist in Australia are unprocurable. It has recommended the appointment of such an officer for a fixed period.

4. *Zamia Palms.*—The question of utilizing the bulbous stems of these palms as a raw material for the manufacture of starch and alcohol has been fully investigated. It has been found that the inner cores of the stems contain about the same percentage of starch as potatoes. The question of their commercial utilization depends mainly upon the cost at which the material can be collected.

5. *Grass Tree Resin.*—Large quantities of this resin were previously exported to Germany. There is now a large demand for it from America. The Institute is carrying out a fundamental investigation of the resin with a view to its more economical commercial utilization in this country.

6. *Western Australian Sandalwood.*—The oil obtained from this tree differs slightly from the sandalwood oil described in the British Pharmacopœia. An investigation is being carried out into the chemical composition and therapeutic value of the oil, with a view to its inclusion in the British Pharmacopœia, and thus to opening up a new industry.

C.—Manufacturing Industries.

1. *Leather and Tanning.*—The tanning industry is one of the most important secondary industries in Australia. If given assistance in developing along scientific lines, it is capable of immense expansion. The Institute has already carried out certain experimental work, and has recommended improved methods for wattle-bark tanning. The Tanning School of the Sydney Technical College is co-operating in this work.

2. *Pottery.*—Though there are numerous deposits of high-class clays and kaolins in Australia, owing to the absence of scientific work they are not yet used for the manufacture of high-class white earthenware, such as is ordinarily used for dinner services, &c. The Institute is carrying out investigations at Ballarat, where a great number of clays have been tested, and very successful results have so far been obtained. Experiments are now being conducted on a larger scale, and it is expected that they will lead to the establishment of a new and important industry. The Ballarat School of Mines is co-operating in the work.

Similarly, numerous tests have been made by the Institute in Western Australia in co-operation with the Western Australian Government, and valuable assistance has already been rendered to the pottery and earthenware industries in that State. The first stage of the work has been completed, and a report is in course of preparation.

3. *Power Alcohol.*—The investigations carried out by the Institute into this problem are of far-reaching importance. As the result of these investigations, a simple and effective method has been discovered for overcoming the difficulty of starting engines "from cold" on alcohol without the addition of ether or other material, a difficulty which has hitherto in other countries very largely prevented the more extended use of alcohol as a fuel. Demonstrations of the process have been given by the Institute before the Motor Traders Associations in Sydney, Adelaide, and Brisbane, and have proved entirely successful. The suitability of various raw materials in Australia for distillation purposes has been fully investigated, and it is believed that if certain economic difficulties can be removed the industry will be started in Australia on a commercial basis as a direct result of the Institute's work.

4. *Posidonia Fibre.*—The question of the utilization of this marine fibre, of which there are very large deposits on the Australian coasts, has been thoroughly investigated. As a result, a method of increasing the strength and flexibility of the fibre has been devised by treatment with dilute mineral acids. The results are being followed up by Posidonia Fibres Limited. This company is carrying out the necessary alteration to its plant to allow for large scale experimental work on the acid treatment, and it is anticipated that valuable industrial results will follow.

5. *Mechanical Cotton Picker.*—A considerable amount of work has been done by the special committee of experts in Brisbane. American patent specifications have been thoroughly examined, and exhaustive laboratory tests made. As a result, an experimental machine, working on a new principle, has been constructed, and will be given a field trial next season.

6. *Engineering Standardization.*—The task of standardization has been tackled, and the Institute has already been successful in securing agreement for standard specifications for (*a*) structural steel sections, (*b*) railway rails and fish plates, and (*c*) tramway rails and fish plates. The work already accomplished in this direction represents very large direct monetary gain to the Australian steel industry, and is also of great benefit to manufacturers and users of steel in Australia.

The Institute has also secured the concurrence of the Engineering Societies of Australia to a scheme for the establishment of an Australian Engineering Standards Association to undertake the work in a systematic and comprehensive manner, along lines similar to those adopted in the United States of America, Great Britain, and other countries.

7. *Miscellaneous.*—Other experimental work in connexion with secondary industries has been carried out in regard to substitutes for tin plate containers, and firms now using board containers have been materially assisted by the Institute's investigations. Investigations on yeasts and bread-making have shown that the period of fermentation for making bread under trade conditions can be materially shortened.

The question of fuel economy, and the recovery of the valuable by-products from coal now wasted, have also received attention. Investigational work is, however, in abeyance, owing to the fact that the necessary funds are not available.

D.—Mining and Metallurgy.

1. *General.*—There is a wide scope in Australia for investigational work in connexion with the mining and metallurgical industries, with a view to the development of new and improved processes, especially for the treatment of low-grade ores and the manufacture of various alloys. The temporary Institute has initiated several investigations in this field.

2. *Mode of Occurrence of Gold.*—Investigations on this matter have been carried out on the Bendigo Gold-fields. Their main object is to determine the principles which have caused the erratic localization of the gold shoots in the quartz reefs, and thus, among other things, to cheapen the cost of deep prospecting. The cost of the work has been borne partly by Bendigo mining companies, and the Mine Managers Association and other mining associations have expressed their appreciation of the valuable results obtained.

3. *Ferro Alloys.*—Investigations have been carried out on the manufacture of ferro-chrome and ferro-tungsten, and economical methods of preparing these alloys have been devised. The results have been of industrial value.

4. *Alunite.*—Methods for obtaining potash salts from various Australian deposits of alunite have been worked out. The results obtained were taken up industrially, but owing to commercial and economic reasons, the industry has not yet been established.

5. *Miscellaneous.*—The question of the manufacture of aluminium in Australia has been inquired into from the commercial point of view. Attention has also been given to other matters, such as the utilization of the natural phosphatic rocks of Australia, and of platinum and osmiridium. The Institute is co-operating with the Imperial Mineral Resources Bureau, established to collect information regarding the mineral resources and the metal requirements of the Empire, and to advise as to action to be taken for the development of the resources.

E.—Miscellaneous.

1. *Chemical Investigations.*—A large number of chemical questions has been investigated and reported upon. A revised list of chemical imports has been compiled on a scientific basis, and has been adopted by the Customs Department and the Statistical Bureau. The results obtained are of commercial and industrial utility. The question of sources for raw material for artificial fertilizers has been investigated, including potash from kelp, wool grease, wood ashes, salt lakes and brine springs, flue dusts from blast furnaces and cement works, and the water hyacinth. In co-operation with the British Nitrogen Products Committee, the question of the nitrogen requirements of Australia has been investigated and reported on.

A great number of other matters in this connexion has been inquired into. The following brief list gives some idea of the variety of subjects dealt with:—Destructive distillation of Australian hardwoods; manufacture of sheep dips in Australia; spontaneous combustion and drying of

copra; the manufacture of indelible inks and pencils; extraction of vegetable oils; condenser tube corrosion; utilization of military gas masks in mine rescue work; manufacture of fire-bricks; utilization of residue of carbide after gas extraction; sulphur from gypsum; anti-fouling composition; preparation of dolomite for furnaces; processes for manufacture of salt; manufacture of fine gelatine; manufacture of materials for cleaning suede leather.

2. *Investigations on Road-making Materials, &c.*—This question has been investigated by a special committee of experts, and a scheme of experimental work has been formulated for the consideration of the Directors of the future Institute.

3. *Weights and Measures.*—The question of scientific control of weights and measures in Australia has been investigated and reported upon.

4. *Leather.*—A large amount of information and expert advice has been obtained on this question, with a view to steps being taken by the permanent Institute to improve scientific methods of control.

5. *St. John's Wort.*—In co-operation with the Imperial Bureau of Entomology, preliminary investigations are being carried out with a view to the control of this pest by means of natural parasites.

6. *Miscellaneous.*—A very large number of raw materials have been tested and analyzed, with a view to ascertaining their commercial utility.

F.—Bureau of Information.

An important part of the work of the temporary body has been the furnishing of information to persons engaged in industry. A Bureau of Information has been established on a small scale, with a library of scientific, technical, and industrial books and journals, all catalogued and indexed on the card system. Information has been furnished on a great variety of subjects to a large number of persons inquiring *re* scientific and technical matters, especially concerning new processes, manufacturing difficulties, and the utilization of new raw materials or substitutes therefor. The increasing number of inquiries received shows that the Bureau has come to fill a place in the needs of the community, and it is believed that this class of work will play a very important part in the work of the permanent Institute.

VI.—Co-operation with the States.

Another important part of the work of the temporary body has been the preparation of preliminary schemes for work of a continuous nature for the permanent Institute, *e.g.*, the establishment of a Forest Products Laboratory in Western Australia, and of a Stock Diseases Experiment Station in New South Wales. One of the most frequent arguments directed against the creation of a Commonwealth Institute of Science and Industry is that it would result in duplication and overlapping of effort in respect to the work of State Scientific and Technical Departments; and it has been stated that no steps have been taken by the temporary body to secure the co-operation of these Departments and of other authorities in the work. A brief review of the facts show that these criticisms are wholly lacking in foundation. Not only did

the representatives of State Governments and other institutions give their assent to the scheme when it was formulated at the original Conference in 1916, but a great part of the work of the temporary body has been carried out in co-operation with one or other of the States. The State Departments, Universities, Technical Schools, and other State or semi-State institutions throughout Australia are actively co-operating in the work, and it is, in fact, only by reason of such sympathetic co-operation that the Institute has been able to carry on work of a permanent nature in the absence of laboratories of its own. The discussion at the Premiers' Conference, in May, 1918, proves, moreover, that the States, on the whole, cordially welcome the Commonwealth proposals.

The following statement shows the various investigations in which the Institute is co-operating with the several States:—

1. *New South Wales.*—Institute co-operating in (*a*) prickly pear scheme; (*b*) white ant pest; (*c*) cattle tick dips; (*d*) worm nodule disease; (*e*) forest products; (*f*) sorghum for alcohol; (*g*) tanning methods; (*h*) yeasts and breadmaking; (*i*) blowfly pest; (*j*) macrozamia.

2. *Victoria.*—(*a*) Viticultural problems at Mildura; (*b*) paper pulp; (*c*) pottery investigations; (*d*) contagious abortion in cattle; (*e*) paper-pulp investigations; (*f*) tuberculosis in stock.

3. *Queensland.*—(*a*) Prickly pear; (*b*) cotton growing; (*c*) blowfly pest; (*d*) castor beans; (*e*) mangrove bark tanning; (*f*) mechanical cotton picker; (*g*) cattle tick pest.

4. *South Australia.*—(*a*) Grass-tree resin; (*b*) tuberculosis in stock; (*c*) paper-pulp investigations.

5. *Western Australia.*—(*a*) Clays and pottery; (*b*) paper pulp; (*c*) forest products; (*d*) cattle tick pest; (*e*) Kimberley horse disease.

6. *Tasmania.*—(*a*) Tuberculosis in stock.

VII.—Difficulties under which Temporary Body has Laboured.

It has already been pointed out that the scheme of organization of the existing body was intended merely to enable it to carry out preparatory work, in order to pave the way for the permanent Institute. The Institute has no laboratories, and only a very small staff of its own. While a very great deal of valuable work has been carried out by the office staff in Melbourne, the organization has had to rely very largely for its research work on Special Committees, members of which work in an honorary capacity, and in their spare time. It is obvious, of course, that difficult industrial research problems cannot be solved as a result of desultory work. A proper staff and facilities, continued effort, and undivided attention are essential for success.

Moreover, since the Bill to establish the permanent Institute has not been passed, the temporary body has been unable to adopt any continuous programme, and no funds have been available for investigations involving any substantial expenditure and continued effort over a period of years. In the belief that the permanent Institute would have been established some time ago, the temporary body made provisional arrangements with various State Government Departments to

co-operate in certain important investigational enterprises. As, however, the necessary statutory authority has not yet been given, the temporary body has been unable to carry out its part. The States are anxious to proceed in co-operation with the Institute, but will not delay action further. This would lead to overlapping and to isolated and fragmentary efforts—a position which the establishment of the Institute was intended to obviate.

Among the leading countries of the world there has recently been a great awakening to the national value of scientific research. The British Government has recently created a new Department of Scientific and Industrial Research, with a fund of over £1,000,000 at its disposal. In France, a new national institution for scientific research on a large scale is being established, with a preliminary grant of £250,000. In Canada, a Research Council has been established on a permanent basis by the Dominion Government to take charge of matters affecting scientific and industrial research in Canada, and to advise on questions of scientific and technological methods affecting the expansion of Canadian industries or the utilization of the natural resources of Canada. In the United States, though the facilities provided for industrial research are probably better organized and more munificently endowed than in any other country, it has recently been recognised that it would be profitable to devise a national organization. A Research Council has accordingly been established, at the instance of the President, for the purpose of developing and bringing into co-operation existing governmental, educational, industrial, and other research organizations. In Japan, a National Research Institute is being established on a large scale, involving the expenditure of over £500,000. In Italy, a sum of £250,000 has been granted, as a first instalment, for the work of a National Research Council. In New Zealand, South Africa, Sweden, and Belgium, national research organizations have also been established.

The illustrations cited above serve to show that throughout the world there is a recognition of the fact that the development of national resources is dependent on scientific methods and research, and they indicate also the path that must be followed in Australia if our industries are to be developed efficiently.

Xanthorrhœa.

Investigations of Grass Trees and their Gum.

By EWEN MACKINNON, B.A., B.Sc.

Australia possesses many peculiar and remarkable plants and animals, but none are more characteristic than her so-called Grass Trees. These plants are a conspicuous feature of many parts from Darwin to Tasmania, and from Perth—where they are known as Black Boys—to Botany Bay. Botanically, they belong to the great family of *Liliaceæ*, and to the genus Xanthorrhœa. The name "Grass Tree," though very descriptive, is a misnomer, as they are not grasses and they are not trees, and again their "gum" is a true resin Some of

AUSTRALIAN GRASS TREES.
Block kindly loaned by the Technical Education Branch, Sydney

the smaller species, however, appear to be without stem, and consist of a tuft of leaves, which are long, narrow, and grass-like, springing almost from the ground. Hence the plant appears like a coarse grass. The larger species, *e.g.*, *X. arborea*, has a stem or caudex 6 to 8 feet high, usually branched, with leaves 3 to 4 feet long; and the Western Australian species are even larger, with stems up to 15 feet, and nearly always branched, and the plant weighs up to 1½ tons. They are crowned by the bunch of grass-like leaves, and their appearance is

still more ornamental when the flowering stem or spike appears from the centre of the bunch, and projects to a considerable height (in some cases 8 or 9 feet) in the large species, or only as many inches in the smallest species. Towards the apex of this cylindrical pole the flowers are borne, and black shining seed is produced for the propagation of the plant. The grass trees would appear to have a predilection for poor, sandy soil, growing under conditions which, judging from the stunted and dwarfed plants usually associated with them, indicate a lack of suitable nitrogenous and other plant foods. Yet in this apparently unfavorable environment the plant is able to elaborate many complex chemical substances to such an extent that not only are some of the substances somewhat different from those found in any other plants, but the different species also contain different substances. The investigation of these plants requires the co-operation of a botanist and a chemist, similar to the work performed on the eucalypts and

X. quadrangulata. SHOWING CORE AND LEAF BASES.
Block kindly loaned by Department of Chemistry, South Australia.

the pines by Messrs. Baker and Smith. The plants are not cultivated in Australia; they require long periods for growth—how long is not known—but, apparently, any time from 15 to 30 years. As they are not found outside Australia and Tasmania, there is little danger of any industry established to exploit them being taken from here, as has happened with other plant industries, *e.g.*, the production of tannin extract in Natal from Australian acacias, and the growth of the eucalyptus in California. The greatest danger, however, was that many of the plants would be destroyed before systematic investigation had revealed the true value of the plant and its products, as, by the methods of collecting the resin up to the present, the plants were destroyed. Several estimates have been made of the quantity of resin available for collection. On Kangaroo Island, it is estimated that there are 500,000 acres under grass trees, with a total amount of 150,000 tons of resin available for collection. There are other places where large quantities

occur, *e.g.*, in Western Australia, on the Otway plains, and in New South Wales and Queensland. An average-sized tree will yield about 25 lbs. resin, though many may yield three times that amount. The stems are like those of palms, and consist of a small central core of tissue, which is covered with a dense coating formed of the persistent bases of old leaves cemented together by the resin. There are about fourteen species of *Xanthorrhœa* in Australia, distributed as follows:—*X. arborea*, *X. bracteata*, *X. hastilis*, *X. macronema*, and *X. minor*, in New South Wales; *X. tateana*, *X. quadrangulata*, *X. semiplana*, in South Australia; *X. preissii* and *X. gracilis* in Western Australia. *X. pumilio* is peculiar to Queensland, *X. australis* to Victoria and Tasmania, and *X. thorntoni* to Central Australia and Northern Territory. *X. media* has been recorded for Australia. Some of these are either stemless or have very short stems, and are of no importance as resin

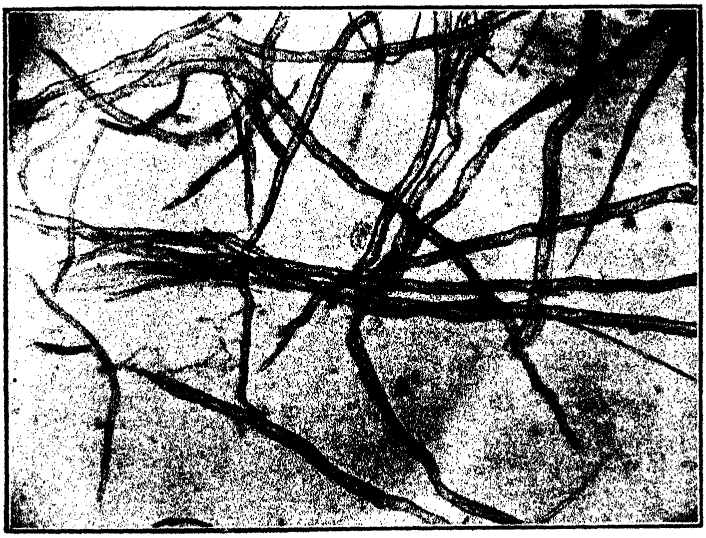


PHOTO-MICROGRAPH OF ULTIMATE FIBRES FROM CORE, *Xanthorrhoea* SP.
Block kindly loaned by Department of Chemistry, South Australia.

producers. The species of any importance that have been at all exploited are:—*X. hastilis* and *X. arborea*, New South Wales; *X. preissii*, of Western Australia; and *X. tateana*, of South Australia and Kangaroo Island.

The resin of *X. hastilis* is, when fresh, of a bright yellow colour, much resembling gamboge, and gives a yellow powder. It is externally darkened by sunlight, but remains yellow on the fracture. It was known at one time as yellow resin of Acaroides, or Botany Bay Gum, and was noticed by Governor Phillip in 1789. The resin of *X. arborea* is dark-red in colour, and gives a reddish-brown powder. That of *X. tateana* is also reddish, but gives an orange powder, and the fracture is of ruby-red colour. The resin of *X. preissii*, of Western Australia, is of a softer nature, and more balsamic in odour and appearance. It is of a dark-red colour, and gives a dark-brown powder. There appears to be a certain amount of confusion as to the identity of some

of these species, and a recent examination of Western Australian *X. preissii* has resulted in a new species *X. reflexa*, which produces blackish gums, being proposed. In many of the chemical investigations already made, the value of the results obtained must be partly discounted, owing to the uncertainty of the origin of the resin. In many cases it has been stated as "Grass Tree resin, red or yellow variety." Most of the resin examined by various German chemists many years ago was apparently New South Wales red or yellow resin. We can probably correctly give the species for the yellow as *X. hastilis*, but the red is doubtful.

The resin is known by various popular names according to the locality. The old name is Acaroid gum (acer = bitter). Other common names are Yacca gum, and Blackboy gum, in Western Australia. The resin of many species is without odour, while others have an agreeable smell, mostly due to the aromatic acids (*e.g.*, benzoic). They are soluble in ether, alcohol, and caustic potash. The Imperial Institute has given the following particulars from typical samples of red (R.) and yellow (Y.) resin, but no specific names are given:—

Moisture—Y., 3 per cent.; R., 3.5 per cent.
Ash—Y., 1.3 per cent.; R., .3 per cent.
Matter insoluble in ether—Y., 23 per cent; R., 16 per cent.
Matter (chiefly woody) insoluble in alcohol—Y., 14 per cent.; R., 4 per cent.
Melting point—Y., 97 degrees C.; R., 110 degrees C.

The value of the resin locally is about £5 to £6 a ton, though during the war prices advanced very much.

The stem, or caudex, consists of a central core of fibrous, somewhat spongy tissue, often hard enough to be called wood. It is surrounded by a thick coating or "husk" formed by the persistent bases of old leaves, lying very closely packed together, and more or less cemented by resin into a hard coherent mass. The bases of the individual leaves vary much in shape, and are an important character in identification. They commonly form flattened, thickish flakes composed of a light fibrous skeleton and skin, serving as a support and container of resin, which forms the main mass of the flake. Exudations and veins of resin often occur in the stem. The name is derived from this fact—"Xanthos" yellow and "rheo" I flow = the yellow exudation, from the first-discovered or yellow resin variety of Botany Bay. When the tree dies, the core decays rapidly, leaving the husk as a thick cylindrical tube. In *X. preissii*, the internal and external diameters vary from 2 to 6 and 6 to 12 inches respectively. When the outer coating or husk is broken up and beaten, the brittle resin is readily reduced to a powder, and is separated from the fibrous parts by sieving and winnowing. With this process there is necessarily much loss of material, and other methods, some of which are patented, have been introduced to reduce the loss, to obtain a purer resin free from fibrous and mineral matter, and to retain the tree in a living condition. The commonest method of collecting the gum is probably by using a "jigger.' This consists of a wooden framework supporting, by hessian generally, a pair of sieves. The top one, with its bagging, forms a hopper in which the broken-up material is collected, and sieved through a ½-in.

wire netting into a second sieve shortly below, made of finer perforated sheet metal, which further sifts out smaller fibrous particles. The resin can thus be graded into two qualities. The Harrison steaming method melts out the resin, thus securing about one-third more gum than by the previous way. It also produces a purer product. This process, however, does not save the tree. The present methods of collection generally result in the destruction of the plants, owing to the common practice of cutting off the top of the plant. If sufficient covering is left as a protection to the core, the tree will live, and can be stripped at intervals of several years. The amount of resin that can be collected varies very greatly. The yellow resin is not plentiful, and an average of about 3 lbs. a tree might be obtained. The red variety from the larger trees, *e.g.*, *preissii*, may average 40 lbs. per tree.

A standard of purity for commercial resin has been suggested thus—

not more than 7.5 per cent. woody fibre;
nor more than 2 per cent. mineral matter.

The resin has not been exported in any quantity, though exaggerated statements have appeared in the press from time to time, especially early in the war. The average figures for six years, 1909-1915, are as follows:—

State.	Total Export.	Average per year.
New South Wales	914 tons ..	152 tons
South Australia	6,414 „ ..	1,069 „
Western Australia	120 „ ..	20 „

In six years 1,831 tons, of a total value of £15,000 (average, £8 per ton), went to England; and 4,826 tons, of a value of £35,500 (average, £7 6s. per ton), went to Germany.

In 1913, New South Wales exported 198 tons, valued at £3,237, and South Australia 1,082 tons, valued at £5,052. German imports from Australia were, in 1911, 379 tons; 1912, 472 tons; and 1913, 700 tons. No doubt it was the exportation from South Australia of over 1,000 tons, of which the greater part went to Germany in 1913, that gave rise to many wild rumours about Germany using it to manufacture explosives. Inquiries were made both by the British authorities in England and Germany, and also by local authorities in Australia.

The quantity of resin imported by Germany during the last few years preceding the war does not support the idea of its utilization for the manufacture of picric acid for explosives. As early as 1846, Stenhouse had shown (*Jour. Chem. Soc.*, 1845-6, p. 10) that by treatment with nitric acid, fairly large quantities of picric acid could be produced. He knew that he could get a return of 50 per cent. from a given quantity of resin. Hence acaroid gum became the chief source of supply. Later, it was found that phenol was a much better and cheaper raw product, so the use of grass tree gum was dropped. The Boer war again led to further investigations, but the War Department's Chemist reported unfavorably on it. Since that time, numerous investigations have been made; and in June, 1917, the Institute of Science and Industry decided to carry out some research work, and appointed a special Committee, of which Professor Rennie, of Adelaide University, was

chairman, with control of the investigations. As the Imperial Institute at South Kensington, London, had also been investigating certain phases of the question, the special Committee was appointed to investigate the chemical constitution of the resin, and the experiments were directed to that end. It is believed that such an investigation is a necessary preliminary to any further inquiries which may be directed towards the commercial utilization of the resin. The products obtained as a result of the investigation are not obtainable in any quantity by the processes used for technical analyses, and the question of cost of production has not been entered into. It is possible, however, that some of them may turn out to be of special value for one purpose or another. Although it may be that the fundamental structure of the resin from all species of grass tree is the same, yet that has not been proved. The investigations have shown that different substances can be obtained by the same process from different species, though possibly these compounds are only by-products of some kind, due to differences in the life-history of the plant, or to differences in the soil, climate, &c. It is evident that we shall not obtain a correct knowledge of the composition of these various resins until a complete and exhaustive research is undertaken upon the several resins collected from the various species, which must be true to name. At the present time, very few of the chemical investigations can be referred to any botanical species, but only to the "yellow" or "red" resins. As a result of investigations by various chemists, there is a substantial agreement as to many products which have been isolated, but some fail to find certain substances present which others have found. The following list shows the great variety of products obtainable by the various methods of examination, such as Distillation, with or without steam, under normal or reduced pressure; by Oxidation with acid or alkali solutions; by Nitration; by Fusion with caustic potash; by Heating in sealed tubes, &c.:—

(1) *Acids.*—Either free or partially combined in the form of esters. Benzoic, cinnamic, paracoumaric.

(2) *Aldehydes.*—Vanillin, para-hydroxy-benzaldehyde.

(3) Products of *Oxidation.*—(*a*) By alkaline permanganate of potash; acetic acid, oxalic and carbonic acids, and vanillin; (*b*) By chromic acid—insoluble chromium compounds.

(4) Products of *Fusion with Caustic Potash.*—Resorcinol, para-hydroxy-benzoic acid, carbonic acid, pyrocatechin, phenol.

(5) Products of *Action of Nitric Acid.*—Picric acid, p.-nitrophenol, acetic and oxalic acids.

(6) Products of *Distillation* with *Zinc* dust in presence of *Hydrogen.*—Benzene, toluene, naphthalene.

(7) Products of *Destructive Distillation.*—Phenol or like product, 17 per cent. tarry matter. The products are not unlike those from wood distillation.

(8) A *residue* obtained by acidification of an alkaline solution consisting of a complex substance which has been named a "resinotannol."

Oxidation results did not prove of value in producing a derivative capable of throwing light on the constitution of the resin. The experiments yielded no product of commercial interest except picric and oxalic

acids, the latter of which can be made more cheaply from other sources. No characteristic dye was obtained from the phenol from the resins, by combining with diazotized aniline, or phthalic anhydride. The yield of p.-oxybenzoic acid depends largely on the temperature of the fusion and the duration of heating.

X. preissii gave 1 per cent. fragrant oil—more fragrant than other species. The distillation was long and continuous before all oil could be separated. *X. tateana* gave a sharp end to oil distillation.

The Special Committee examined chiefly—

(1) Red resin from *X. tateana* of Kangaroo Island.

(2) Red resin from *X. preissii* from Western Australia; and

(3) Yellow resin, which can be obtained from about 1 per cent. of the trees on Kangaroo Island, and possibly of a different species to (1).

In *X. preissii*, parahydroxy-benzaldehyde was not detected.

By steam distillation from strongly alkaline solutions, the following substances not hitherto found in *X.* resin have been obtained:—

(1) Red Resin (*X. tateana*), Kangaroo Island—

(*a*) A small quantity of fragrant liquid of vanillin-like odour.

(*b*) Pæonol (2-hydroxy, 4-methoxy-acetophenone).

(*c*) Traces of material of higher boiling point.

(2) Yellow Resin (*X. tateana*), Kangaroo Island—

The same substances as in the red, with a much greater quantity of pæonol; and in addition—

(*d*) Hydroxy-pæonol in quantity about two-thirds of that of the pæonol.

(3) Red Resin, from *X. preissii*, Western Australia—

Pæonol and hydroxy-pæonol as above, also—

(*e*) Citronellol.

(*f*) Methoxy-diphenyl-ether, and two other unidentified substances.

According to an investigation by the Imperial Institute, benzoic acid was not found in the resins tested; and in the waste product from steam-prepared resin, H. G. Smith was unable to detect even traces of benzoic acid, and Tschirch and Hildebrand, in the red resin examined, recorded that no cinnamic acid occurred.

The Imperial Institute concluded that "the composition of both red and yellow resin is very imperfectly known, and thorough investigation is desirable."

The product of greatest interest is that of picric acid. This was first made in 1771 by Woulfe, by the action of strong nitric acid or indigo. Liebig was the first to analyze it and prepare its salts. Dumas gave it its present name from the Greek word meaning "bitter." Laurent synthesized it from phenol, and ascertained its chemical constitution. Prior to its manufacture from phenol, it was made from "Acaroides resin," or Australian Grass Tree Gum—the yellow variety from *X. hastilis*, most likely; but the origin of the red variety is uncertain.

The yields of picric acid from the different species vary very much. The following figures are given by Mr. H. G. Smith:—

New South Wales yellow resin gave 48 per cent., 48 per cent., and 36 per cent. picric.

Kangaroo Island red resin gave 46 per cent., 44 per cent., and 44 per cent. picric.

Western Australian red resin gave 23 per cent. picric.

Queensland red resin gave 24 per cent. picric.

These are percentages for the unpurified acid. It has been found that the purification of picric acid made from Grass Tree resin is a laborious matter, it being troublesome to remove all traces of colouring matter, and to obtain a solid with constant melting point. It is not at all easy to compare the cost of production of picric acid from X. resin and from phenol, as so much depends not only on the yield obtainable, but also on the consumption of nitric acid, and on the time and labour involved in the purification of the product.

Since the outbreak of the war, the possibility of utilizing these resins as a source of picric acid was independently investigated by the Imperial Institute, a sub-committee of the New South Wales Munitions Committee, and a sub-committee of the Federal Munitions Committee. The New South Wales Committee concluded that, "Taking everything into consideration, it would be more economical to manufacture picric acid from the phenol recoverable from the available supplies of coal tar than to manufacture it from Grass Tree resin."

When 12 or 13 lbs. of nitric acid are used to 1 lb. of resin, 50 per cent. is the maximum of picric acid obtained, so that it requires 24 lbs. of nitric to make 1 lb. of picric from Grass Tree resin. To make picric from phenol, the rate is only 4 lbs. to 1, *i.e.*, one-sixth of the amount of nitric is required. The amount of phenol obtainable from the coal tar produced annually in New South Wales may be calculated. Seven million gallons of coal tar made annually yielding .5 per cent. phenol, would produce 350,000 lbs. phenol, and this would provide 660,000 lbs. picric acid, which is now going to waste. With nitric acid at £24 a ton, the following rough estimate of cost of manufacture of 1 lb. of picric acid from resin and phenol respectively is calculated:—

With Grass Tree Resin—

Nitric acid	5s. 0d.
Yellow resin	0s. 4d.
Purifying resin	0s. 2d.
Manufacturing, &c.	2s. 0d.
	7s. 6d.

With Phenol—

Nitric acid	0s. 10d.
Phenol	2s. 0d.
Sulphur acid	0s. 2d.
Manufacture	1s. 6d.
	4s. 6d.

It thus becomes a question of the cost of phenol and the cost of the large ratio of nitric acid required which it has not been found possible to reduce sufficiently to make the manufacture of picric acid profitable from Grass Tree resin in competition with cheap phenol, which requires so little purification. The recovery of the nitric acid after the picric had been obtained, or by the preparation of the by-products, would reduce the cost. But the preparation of by-products depends on the development of industries which are not at present established in Australia. With cheap synthetic nitric acid and improved methods, worked on a large scale, the preparation from resin is a possible commercial proposition.

In addition to the question of the production of picric acid from the resin, the Imperial Institute has been particularly concerned with such questions as—

(1) The use of the resin for making varnish, and generally as a cheap substitute for shellac.

(2) The use as a dye.

(3) The distillation or fusion with alkali, with a view to the production of commercially useful by-products.

X. resin has long been used for making varnish. Locally, it has been used as a lacquer for protecting tins for meat preserving, for inferior French polish in the furniture trade, and as a colouring for varnish used to imitate cedar. The Imperial Institute carried out tests with varnish made from the resin, and reported that it had less body and was less resistant to the action of air and moisture than shellac, though it is superior to common resin. Owing to the present high prices of shellac, it is being used in England more extensively for cheap spirit varnishes, especiallly those used for floors and common wooden articles. In the *Farber Zeitung* (Germany), December, 1901, it is stated that both forms of Grass Tree resin (red and yellow) are used in Germany for the preparation of spirit lacquers for coating metal, and that the resin in alcohol has replaced the ordinary gold lacquer used in coating the brass parts of instruments. In combination with copal and shellac, the resins are made into transparent wood varnishes, and these can be applied to metals without previous warming, and they do not bleach. Mr. J. C. Earl, in his Bulletin on Grass Trees (Adelaide, 1917), states that unless the spirit varnish solution is highly concentrated, it has little viscosity, and readily soaks into wood. If, however, the solution is too concentrated, the surface of the varnish shows pronounced "checking" a day or two after application. The varnish surface is readily affected by water, and is at all times very brittle.

The appearance of stains on a resin-varnished surface exposed to water or moist conditions for some time was thought to be due to the presence in the resin of soluble benzoic and cinnamic, or other acids. In order to test this, Mr. Earl removed all free acids from the resin by treatment with hot caustic soda solution, under pressure of 25 to 30 lbs. This treatment hydrolysed any esters present, and removed any acids produced by their hydrolysis. Comparative tests were then made with the untreated and the prepared resin varnish; these were poured on to glass plates and allowed to thoroughly dry for a few weeks, and were then immersed side by side in water. The varnish from the untreated

resin showed opaque patches after two hours' immersion, and was completely opaque after four hours, while that from the prepared resin was hardly affected by four hours' immersion. Local varnish-makers also state that varnishes become too cloudy when made from Grass Tree resin. Experiments along the above lines may lead to some successful method of treatment, and the investigation shows the need for knowing the composition of the resin to be treated, as the various acids vary in their relative proportions, or the resin of different species may contain very different compounds. The addition of a small proportion of castor oil to such varnishes renders the film somewhat tougher and softer, and lessens the tendency towards checking.

The colour of the resins, whether red or yellow, the difficulty of preparing any of the derived products free from colour, and the stability of the colour, naturally led to the use of the resin as a dye; and the Germans were credited with using it to manufacture various fine dyes. The presence of paraoxybenzoic acid and of resorcinol would be starting-points for the preparation of fine chemicals or dyes. The percentage of these present in the resins vary very greatly, as shown by the following anaylses:—

1. Hlasiwetz and Barth.—Yellow resin—13 per cent. p.-oxybenzoic, 1.4 per cent. resorcinol.
2. Earl.—Red resin—8 per cent. p.-oxybenzoic, no resorcinol.
3. Imperial Institute.—Red resin—1.5 per cent. p.-oxybenzoic, 2 per cent. resorcinol.

A number of woollen materials (11) and silk materials (2) were submitted to the Imperial Institute, with the statement that they were dyed in Australia with resin of *X. tateana*. The tints varied from bright greenish-yellow to fairly dark-brown. The colours were found not to be fast to soap.

The Institute made an exhaustive series of dyeing trials with red and yellow resins. A fair range of tints, varying from pale yellow to deep brownish-black, was found to be obtainable on wool and silk by the use of suitable mordants; but the tints were weak in comparison with those given by fustic, especially in the case of the yellow resin. Other disadvantages were that large quantities of the resin had to be used, and that they could be employed only in alkaline solution, which is especially undesirable in the case of wool. Both resins proved quite unsuitable for use on cotton.

In spite of these disadvantages, the results of the tests seemed sufficiently promising to make it worth while to consult dye-extract makers and dyers in the United Kingdom. They proved that the resins could not compete successfully with the natural dyes already in use, such as fustic, or with the synthetic yellow and brown dyes, all of which were cheaper, and gave better results than the Grass Tree resins. They also pointed out that the colours given by the resins are chiefly required for woollen fabrics, but that the use of them for dyeing wool is objectionable, as they have to be dissolved in alkalies, which cause serious contraction of the wool fibre.

With our present knowledge of these resins, there does not appear to be any likelihood of using them as dyes.

The core of *X. preissii* has been proposed by Mr. E. A. Mann as a commercial source of alcohol. It consists of a somewhat soft cellular material bound together by fibrous bundles, the whole being about hard enough in large specimens to be called wood. It has also been used as a cattle fodder, and an analysis gave 50 per cent. carbohydrates, including 10 per cent. reducing sugars, and 16 per cent. non-reducing sugars. It appears to be readily fermentable, yielding a clear alcoholic spirit. (See *J.S.C.I.*, 1906, 30th November.) Mr. Earl examined *X. quadrangulata* of South Australia, and obtained 13.3 per cent. of matter (calculated on core dried at 100° C.), soluble in water. The presence of glucose or fructose was indicated by the formation of osazones, but ultimate analysis indicated not more than .5 per cent. of cane sugar. In this case, the alcohol would be due to fermentation of some of the other carbohydrate material.

The fibrous part of the core has also been used to make paper. A pulp of a satisfactory kind was obtained in South Australia, but was difficult to bleach. The bulkiness of the material is a disadvantage on account of the large volume of liquor which must be used to completely cover it in the digester. The Imperial Institute obtained a yield of only 23 per cent. of air-dry pulp calculated on the dried core. The leaves of *X. semiplana*, South Australia, did not present much prospect of commercial value for paper-making, though the leaf bases should be of value, and possess the advantage of requiring no preparation before placing in the digester.

The distillation of the outer part of the trunk has been advocated by Mr. H. Rowley, but the products are much like those of ordinary wood distillation, consisting of tar, aqueous fluid containing acetic acid, methyl alcohol and gas.

There are numerous other ways in which the resin has been used or experimented with. They are not yet of much importance, but the articles may be briefly listed as follows:—In making linoleum, sealing wax, paints, disinfectants, sizing paper, briquettes (Mr. Crew, of Western Australia, uses 1 part resin to 3 parts powdered coal), fire lighters, packing material, &c.

Mr. Wray proposed the use of the stems as a source for gas; but the free carbon settled in and choked the pipes.

It would appear that, speaking generally, for whatever purpose it is desired to use Grass Tree gum, there is already in use a substance which is cheaper, and, in very many cases, better.

The Rat Problem.*

By THOMAS PARKER, F.R.C.V.S.

The brown rat (*Mus decumanus*), sometimes referred to as the common brown Hanoverian or sewer rat, is larger than the black rat (*Mus rattus*).

It is believed to have made its first appearance in this country in the year 1729, being brought by ships trading with the East. It has now almost superseded the black rat, being not only larger, but a more formidable animal. It should be noted, however, that during recent investigations within the London district, both species have been found living in harmony, not only on the same premises, but in the same rooms. Furthermore, on one floor of a factory in Holborn, not only were both species of rats captured, but also specimens of the Alexandrine rat—the brown variety of the *Mus rattus*, and the black variety of the *Mus norvegicus*.

Fecundity.—Rats commence breeding when six months old, and are fully grown a few months later. The period of gestation is about three weeks. They may have several litters in the year, each litter comprising on an average eight young. They are born naked and blind, are covered with hair on the eighth day, and are able to see on the thirteenth day. On the twenty-first day they have reached the size of a mouse, and are turned out to shift for themselves when about six weeks old. It has been calculated that the progeny of a single pair of rats may amount to 800 in one year. It will be evident, therefore, that rats may increase in numbers very rapidly if undisturbed and sufficient food is available. Mice breed at six weeks old, and are fully grown at three or four months old.

A Menace to Public Health.

Rats may prove to be a real menace to public health in several ways, the chief of which are, briefly—

As carriers and transmitters of dangerous diseases.
By contaminating food and water supplies.
By causing insanitary conditions generally.

Besides the *Trypanosoma lewisi*, a protozoal parasite which is harmless to its natural host and not known as a parasite of man, the rat is a carrier of two other protozoa, namely, *Spirochæta icterohæmorrhagiæ* and *Spirochæta morsus muris*, which are responsible for two serious diseases in man, known respectively as—

Weil's Disease, or Spirochetal Jaundice; and
Rat-bite Fever.

Other diseases that require special consideration are—

Plague;
Trichinosis; and
Tuberculosis.

* Reprinted from *The Veterinary Journal*.

1. *Spirochetal Jaundice* occurs in most parts of the world, but most commonly in Japan. It was frequently met with amongst the allied troops in France, the trenches being infested with rats. Although this disease has been conveyed to man by rat-bites, it is probable that contaminated food and water is the most important source of infection.

2. *Rat-bite Fever* has been known for a long time in Japan, and cases of similar illness have been described in this country, the United States of America, and elsewhere. During 1918, rats caught in and about the city of London were examined by Alexander Foulerton, F.R.C.S., for the presence of parasites causing these diseases. Of 101 rats examined, four brown rats were found affected with *Spirochæta icterohæmorrhagiæ*, whilst of six rats examined for *Spirochæta morsus muris*, none were found affected. Whilst it has been clearly proven that rats capable of conveying spirochetal jaundice have been found within this country, it would be unwise, on the other hand, to conclude that rats capable of conveying rat-bite fever do not exist, simply because six were examined for that disease with negative results.

3. *Plague* is a specific and infectious disease affecting man and some of the lower animals. Between the year 1896 and the beginning of 1905, no fewer than 3,150,000 persons died from plague in India. With the ending of the great outbreak of plague in 1664-1679, this country was free for more than 200 years. According to a memorandum issued by the Local Government Board, outbreaks of plague have occurred periodically during the past twenty years at several of our ports, and, in view of these facts, sanitary authorities are advised to be always on the alert, and especially for ascertaining the cause of any recognised excessive sickness in rats, or of human illness of a doubtful nature associated with sickness or mortality in rats in the same district.

As rats are subject to plague, and are often killed by it in great numbers, they are the most dangerous of all animals so far as the spread of the disease and the creation of new centres of infection are concerned.

It should be remembered, however, that fleas form the intermediaries between the diseased rat and man. When rats are dying of plague their blood is literally swarming with the bacilli of that disease. Fleas feeding on plague-infected rats get plague bacilli on to their mouth parts, and myriads of them are, of course, sucked up into the stomach with the blood. Those on the proboscis may be transferred directly to the next victim that it is thrust into, and those in the stomach may be carried for some time, and finally liberated when the flea is feeding again, or when it is crushed by the annoyed host. In fact, the latter is probably a common method of infection, for the bacilli that are liberated when the flea is crushed may readily be rubbed into the wound made by the flea-bite, or into abrasions of the skin due to the scratching. A useful hint to remember would therefore be—Kill the flea, but don't "rub it in."

The rat flea (*Ceratophyllis fasciatus*) occurs on both the brown and the black rats, on the house mouse, and frequently on man.

The common human flea (*Pulex irritans*), although regarded primarily as a pest of human beings, often occurs very abundantly on cats, dogs, mice, and rats, as well as on some wild mammals, and occasionally on birds.

The dog and cat fleas (*Ctenocephalus canis* and *felis*) are very often troublesome household pests, besides being frequently found on rats.

Fleas usually leave rats as soon as they die, and, of course, seek some other source of food.

Furthermore, human fleas bite rats, and fleas found on dogs and cats bite both human beings and rats. Again, as human fleas and fleas found on cats and dogs can live on rats as casual parasites, they are able, therefore, to play an important part in the transmission of plague from rat to rat, or from rats to human beings, and *vice versâ*.

4. *Trichinosis* is a disease of man and animals caused by a parasite —small worm hardly visible to the naked eye—called the *Trichina spiralis*.

Human beings acquire the disease by eating the flesh of infected pigs, and pigs become diseased through the agency of trichinous rats.

The infected flesh contains larval *Trichinæ spiralis*, and when it is eaten by carnivorous animals the larvæ are set free from the muscle by the action of the digestive juices. When they reach the intestines they become adults and sexually mature. Each female gives birth to a large number of embryos. Some of these are excreted in the fæces, but most of them are carried to the muscles in the blood stream. The embryos, which invade the muscles, become coiled up and surrounded by a cyst wall formed by the tissues, and they remain alive in this situation for a considerable time. Animals may be infected not only by eating the flesh of other infected animals, but also by consuming other food which has been soiled by fæces containing the larval forms. It will be readily understood, then, how pigs may infect each other through their fæces. It should be borne in mind, however, that probably the main factor in the upkeep of *Trichina spiralis* is the rat, for these animals are very easily infected, and are not infrequently, in nature, harborers of the parasite. Again, as they commonly exist about piggeries, they may soil the food of the pigs with their excretions while the parasites are in their intestines, or they may be eaten by pigs, and so give rise to disease in the latter animals. As an illustration of how human food may become contaminated with the active elements of this most repulsive disease through the agency of rats, the following case will suffice:—

In February, 1909, at Exeter, two persons who had consumed some salted pig's flesh became seriously ill. One of them, a labourer, was thought by his medical attendant to be suffering from trichinosis. A specimen of the salted pig's flesh was then sent to the Veterinary Department of the Board of Agriculture, where it was examined, and found badly infested with *Trichina spiralis*. On making inquiries at a farm, it was found that the flesh had come from a sow which had been ailing for about two weeks before it was slaughtered. Although the sow was in good condition and fed well, she had shown great difficulty in using her hind-quarters, so much so that she had even to be assisted to rise. On this account she was slaughtered, pickled, and used for food. On making further inquiries, the farm premises were found to be overrun by rats. One of these was secured, and upon examination its abdominal muscles were found to contain a very large number of

trichinæ. Small pieces of the abdominal muscles were then—for experimental purposes—fed to a white rat, which died four days after eating the diseased flesh. On examination, adult trichinæ were found in the intestines. These intestines were fed to another rat, which also died four days later. Adult trichinæ were found in its large intestine. The carcass and intestines of this rat were then fed to three white rats. The carcass was freely eaten, but the intestines appeared not to have been touched. Seventeen days later two of them were found dead, and in the muscular parts of the diaphragm of one of the latter encysted *Trichinæ spiralis* were found.

It would appear perfectly clear, therefore, that not only did the muscles of the rat secured at the piggery contain living trichinæ, but that it was highly probable that the sow became infected through the agency of diseased rats on the premises.

5. *Tuberculosis* of the rat, sometimes termed rat-leprosy, is a chronic infective disease which has been found to exist in 5 per cent. of rats specially examined in Odessa and Berlin. The disease has also been described as existing in rats in this country. The exact relationship between rat tuberculosis and forms of tuberculosis amongst other animals is uncertain, but it is believed to resemble tuberculosis of birds more closely than any other variety.

Pseudo-tuberculosis is the term applied to another disease—highly infective—which exists as affecting the rat. In fact, in 1916, an outbreak occurred amongst trench rats in France, a considerable number becoming infected.

As the rat possesses a high degree of immunity against the micro-organism causing the common form of human tuberculosis, it is conceivable that the human subject may, in a similar degree, possess natural immunity against the so-called rat tuberculosis.

It has been definitely established, however, that human beings do suffer from the same form of tuberculosis as found in cattle; and by experience one is aware of the fact that not only healthy, but also tuberculous carcasses and organs, whilst hanging in private slaughter-houses, are commonly overrun by rats. These rodents often cause serious damage to healthy carcasses; but when they overrun and eat into tuberculous material, and, having got their limbs, &c., well contaminated, pass on either to a healthy carcass within the same or adjoining slaughter-house, or to some part of the district, perhaps a dwelling, the possibilities of spreading disease are by no means negligible.

Hungry Rats are Ferocious.

Many years ago, a vessel carrying cattle to this country was wrecked off St. Mary's Island, on the north-east coast. Some weeks later a number of workmen had occasion to visit the vessel. Not long had they been on board when large numbers of long lean rats made their appearance and attacked the men. The latter took refuge up the rigging, and finally had literally to fight their way overboard and make their escape by rowing from the ship "for all they were worth."

The late Mr. R. Stephenson, M.P., related a peculiar affair. In the Walker colliery, in which many horses were employed, the rats had accumulated in great multitudes. It was customary, at holiday times,

to bring to bank the horses and fodder, and to close the pit for a time. On one occasion, when the holiday had extended to about a fortnight, during which the rats had been deprived of food, on re-opening the pit the first man who descended was attacked by starving rats, and speedily killed and devoured. Other peculiar instances are on record, including one where patients in hospital at Goccrito, Trinidad, suffering from leprosy, had their toes eaten off by rats. The rats seemed to know that the patients were too weak to defend themselves against their attacks.

Damage done by Rats.

It has been estimated that the damage done to foodstuffs alone amounts in value to no less than £15,000,000 annually. If to this were added the amount of loss through destruction of articles of various kinds, other than foodstuffs, the total sum would be enormous.

Goods stations and other railway premises, docks, wharfs, cattle and pig lairs are all frequented by rats. In town and country alike, and in towns in particular all the year round, they frequent common sewers, hen runs, allotments, market gardens, dwellings, shops (butchers', grocers', fish, confectioners', fruiterers', &c.), bakehouses, cafés, wholesale meat establishments, slaughter-houses, triperies, warehouses, granaries, flour mills, paper mills, large stores, workshops and factories, sewage farms, scavenging tips, knackeries, marine stores, hotels, fancy goods and millinery establishments, and other premises too numerous to mention. In town and country, rats frequent rubbish heaps in search of food, and occasionally migrate from such centres in large numbers. On farm premises, corn, cattle food, potatoes, and other kinds of foodstuffs are destroyed. Even chickens and young ducks are carried off. By burrowing beneath and in close proximity to buildings, rats frequently let down the drains, thus bringing about open joints and other insanitary conditions. In search of water, pipes are gnawed through, causing leakage and the flooding of premises. Woodwork within dwellings, offices, warehouses, and buildings of every description receives particular attention. Walls may be riddled until the building is simply honeycombed. Within butchers' shops, during the night, rats will climb down the iron rods until they reach suspended quarters of beef, and cause an immense amount of damage by eating into the fleshy parts. In drapery and house-furnishing establishments, the annual damage amounts, in various instances, from £50 to £250; in fact, ten or a dozen fur muffs may be destroyed within one night, and curtains, ladies' hats, towels, blankets, and other softgoods are known to be destroyed regularly. The hair seating of chairs is sometimes gnawed through and the stuffing removed, presumably for the purpose of nest-making. It must be remembered that the foregoing are only a few samples of the innumerable kinds of foodstuffs and articles damaged. A precise list of material damage caused by rats would, undoubtedly, be most startling.

Preventive Measures.

Whatever measures are adopted against rats, by way of prevention, those that are calculated to make it impossible for them to obtain food and water should be considered as being the most important. Animal foodstuffs used in stables, byres, kennels, poultry farms, and other premises should be kept in metal or sheet-iron bins.

Ricks surrounded by 5 ft. 6 in. high galvanized-iron sheetings dug 2 ft. 6 in. into the ground are effectually protected. Another method is to build them on stone piers surrounded by a wide inverted pan or saucer-shaped rim of tin sheeting; the piers should be 3 feet to 3 ft. 6 in. high, with the protecting rim near the top. Other buildings are difficult to repair, but, where possible, iron sheeting, brickwork, and cement should be used. In some cases it would be impossible, short of re-building, to render premises rat-proof. In piggeries and poultry runs the animals should be fed, where possible, in the presence of attendants, care being taken to remove all foodstuffs not required.

Refuse must not remain unprotected within the yards of private dwellings. All vegetable matter, bones, or other such unusable waste foodstuffs, should be burned, and ashes kept within properly covered receptacles.

No waste foodstuffs of any kind should be thrown indiscriminately into the back streets for the purpose of feeding stray dogs. Similar precautions particularly apply to those in charge of cafés, restaurants, hotels, and shops of various kinds. It matters not whether it be within a theatre, picture hall, railway carriage, railway station, office, workroom, tea room, warehouse, workshop, factory, or any other place where small or large numbers of people have their meals. It should be considered as a public offence either to throw pieces of biscuit, bread, fat, or other waste food on to the ground, or leave such articles lying about. Any such waste material as cannot possibly be utilized should be carefully disposed of by burning. Within slaughter-houses and other places, garbage and refuse should be kept until removal for destruction within properly constructed galvanized-iron receptacles. Everything possible should be done to remove rubbish heaps. Within stores of every description the contents should be moved as frequently as possible, and within large warehouses packages should be so arranged as to reduce the privacy of the rodents to a minimum. Burrows from which rats have been driven, or which lead to others, may sometimes be successfully intercepted by being filled with a mixture of cement, sand, and broken glass or crockery.

It is highly essential to have defective drains attended to, and wherever possible old or disused drains should be removed. As vessels arriving at the various ports are almost certain carriers of rats, they should be dealt with as soon as possible on arrival. Another matter requiring careful attention is the protection of natural enemies of rats and mice. These include owls, hawks, buzzards, ravens, stoats, and weasels.

Remedial Measures.

Before referring to the various measures to be recommended for immediate application, it will, perhaps, not be out of place to briefly describe a method which has for its object extermination by directly opposing the ordinary laws of nature. It is known as the "Rodier" method.

Bearing in mind the number of young in each litter, and the number of litters produced within a year, it is believed that were a scheme

adopted which would, in effect, with certainty gradually reduce the number of females, success would be assured, for it is almost certain that the time would arrive when the males would co-operate in completing the process of destruction. Rodier claims that by the present methods more males are caught than females, with the result that those not caught live in a polygamous state. Because of being polygamous, the females are more prolific than they otherwise would be, and produce more females than males. The way to exterminate rats is to make and keep them polyandrous—that is, the males in excess of the females; and the way to do this is to catch the rats alive and uninjured, kill the females, and liberate the males. When this is done, the males will persecute the females that are not caught, and thus prevent breeding. They will also kill the newly born, and when they largely exceed the females in numbers they will worry the remaining ones to death. By this means all the females will be exterminated, and the males remaining will finally die of old age. The greater the excess of males, the quicker the extermination.

To put into operation such a scheme, it would be necessary for all rat-infested premises to be thoroughly equipped for the purpose of catching rats alive and uninjured. Furthermore, large numbers of rat-catchers would have to be employed to regularly visit such premises for the purpose of separating and killing the females and liberating the males.

Again, it would be equally essential for all districts to be operating continuously in the same direction. Otherwise, having regard to the migratory habits of the rodents, the scheme would be hopeless. Were it shown that destruction by baiting accounted for as many females as males, then, providing the "Rodier" method were found practicable of universal application, a combination of the two methods would be well worth consideration. Before considering the application of any such scheme, however, it would be desirable that the probability of its success should be thoroughly investigated, not only by specially designed experiments, but also as to whether its application could be properly maintained throughout the country. In the opinion of the author, even were the method proved theoretically correct, it would probably fail for want of co-operation, for there are few people who either care to handle rats, detain them on their premises alive, or liberate those already secured.

The methods of destruction may be described under the following headings, namely:—Baits, Poisons, Gassing, Trapping, Hunting, and Virus.

Baits.

It is commonly believed that faint traces of the oils of rhodium and aniseed attract rats. It has been proved, however, that instead of improving the bait they have the contrary effect. And of all the baits tested, the one that has been found most readily accepted is dry bread. The tastes of brown and black rats have been found to be practically identical, and the following table will serve to illustrate the merits of the various foodstuffs used as bait in experiments carried out within the Zoological Gardens, London. The percentages given are based on the

ratio between the attractiveness of the various baits and plain bread—the favorite food, which is represented by the figure 100:—

Bread (plain)	100	Fish (smoked)	20
Bread (faintly flavoured with rhodium)	40	Malt	20
Bread (faintly flavoured with aniseed)	30	Maize	20
Bread (soaked in milk)	60	Dripping	20
Oatmeal	80	Cabbage	20
Tallow	70	Potatoes (mashed with milk)	20
Banana	60	Lard	10
Flour and water	50	Bacon	10
Oats	50	Beef extract	10
Barley	50	Lentil meal	10
Tripe	50	Fish (fried)	10
Bloater paste	30	Raw meat	0
		Sugar	0
		Apple	0

Notwithstanding the preference for certain foodstuffs used as bait, as indicated by the table submitted, no hard-and-fast line can be laid down to suit all conditions, for rats, like many other animals, may, under varying circumstances, differ in their tastes. For example, quite recently the author tested the most favoured and one of the least favoured baits—as found by the London tests, and illustrated in the table—namely, bread and meat. The bread was plain, and the meat was minced. Each was mixed with barium carbonate. They were both laid down at the same time and place in the evening, and on making an inspection the following morning it was found that the meat bait had all been removed, whilst the bread bait remained untouched. Again, where, after a while, the bait is refused, a change should be offered.

Poisons.

Phosphorus, arsenic, and strychnine are often used in the preparation of rat-pastes or vermin killers, but, as they are all rapidly fatal in their effects on man and the domestic animals, and therefore dangerous, are not recommended. There are others which, whilst being rapidly fatal to rats, are comparatively harmless to domestic animals. These are barium carbonate and squill.

Barium Carbonate.—Although 1½ to 2 grains suffices to kill a rat, barium carbonate is more or less harmless to domestic animals, cats and chickens withstanding 10 to 15 grains, and an average-sized dog over 100 grains. It has also the advantage of being cheap, tasteless, odourless, and therefore easily made attractive by mixing with a suitable bait, and has been found to be as effective as the more dangerous poisons, such as phosphorus and arsenic. The bait may be prepared in the following manner:—Make a paste by well mixing equal parts of the powdered barium carbonate and tallow-fat or dripping and spread it over thin slices of bread exactly as one would do with butter. Then, having firmly pressed the slices together to form sandwiches, they are cut into small squares ready for use. Of course, it may be mixed with any other bait found equally or more acceptable. Owing to the action of barium carbonate on the lining membrane of the stomach the rats are induced to leave their holes in search of drink. It is recommended, therefore, to place within reach, on the day following the treatment, shallow bowls containing a solution consisting of equal

parts of liquid squill and milk; the rats being thus made to partake of more poison in their efforts at relief.

Squill may be obtained either in the form of a powder or of a solution. Although comparatively harmless to domestic animals, it is extremely toxic as far as rats are concerned, the minimum lethal dose being only half a grain. Mix the powdered squill with tallow or dripping, or with either of these fats and oatmeal. The mixture should be smeared on bread, the latter being then cut into small pieces. In the liquid form squill may be prepared for use in the following manner: —Mix equal parts of liquid squill and milk, and to each pint of the solution add 1 lb. by weight of bread.

Of all rat poisons, squill solution is believed to be the most effective, and has been recommended in preference to barium carbonate for the following reasons:—

(*a*) It is three times as toxic for rodents.

(*b*) It is even less harmful to most domestic animals. The one point against the use of squill, however, lies in the fact that at present it is somewhat more expensive than most other poisons.

There is always a possibility of a rat dying under flooring or behind wainscoting, either through poison or otherwise. If a rat from a drain takes poison, and cannot regain its habitation, the carcass will most probably become putrid. If such a rat dies near a fireplace or hot-water pipe, the stench will be intensified. Chloride of zinc is a good deodorizer in such cases, and combines with and neutralizes the offensive chemical products of putrefaction. If necessary, a hole should be bored with a bit and brace in the vicinity of the supposed source of origin of the odour if possible. Some perfume or pinewood oil can be added to the zinc chloride, which should be applied through the hole. A cork will close the orifice, and can be withdrawn from time to time to ascertain whether the nuisance has abated. Where possible, however, it is advisable to remove the carcass immediately its presence has been detected.

Gassing.

Of all the methods advocated, gassing, under certain conditions, is the quickest and most certain for destroying rats on a large scale. When employed in buildings or other places where the runs are not easy of access, gassing has the advantage over all others in that it kills not only the adults, but also the young or newly-born in their nests. The most suitable gas to employ, and the one recommended, is sulphur dioxide.

Sulphur dioxide is a heavy gas, and may be prepared by burning sulphur in air or oxygen. It is non-inflammable, and has a pungent, suffocating odour. It is comparatively cheap to prepare, and is quite harmless to man and the domestic animals when inhaled in small quantities. When sulphur dioxide gas is driven into rat holes under pressure, the whole network of runs is permeated in a few seconds, making the existence of the rats underground impossible. Although many of the rodents escape only to die in the open, some, no doubt, recover. The gas kills many of the rats by immediate suffocation, whilst those that escape into the open die from acute congestion of the lungs. To secure rats

bolting from the runs, the co-operation of a dog is desirable. For the destruction of rats on board ship, the method just described may be strongly recommended; and, no matter whether employed on land or ship, the fact that sulphur dioxide gas is a disinfectant as well as a deodorant may be considered an advantage. For rat destruction on board ship, sulphur candles have been employed with success by the Port of London Authority. Probably the most successful means at our disposal for using sulphur dioxide gas is an apparatus manufactured by the Clayton Fire Extinguishing and Disinfecting Company Limited, London. The Clayton machine is provided with a generator, in which the gas is made and driven through a hose by means of a powerful blower.

Two other bodies may be employed for causing rats to leave their runs when hunting along hedgerows or in old farm buildings where the runs are within thick walls:—

Carbon disulphide is a colourless, heavy, and extremely volatile liquid. It may be employed by soaking wadding, cotton waste, or some such material and placing the latter into the hole and then immediately covering the hole in. In this way the vapour is allowed to permeate the runs. As the vapour of carbon disulphide is highly poisonous, it must be used with caution, and no light or smoking should be allowed during its application.

Acetylene is a colourless, rather heavy gas, having a peculiar, unpleasant odour. It is made by decomposing calcium carbide with the aid of water. When employed along hedgerows, pieces of calcium carbide within tow may be placed within the entrance of the run, then, after saturating with water, the entrance is quickly closed in with pieces of turf. Owing to acetylene being not only highly poisonous, but exceedingly explosive, great care must be exercised as to its application, which should not be within buildings.

TRAPPING.

There are numerous kinds of cage and other traps on the market, most of which are more or less successful. Probably the most successful type is the *Brailsford Trap.* It consists of a long narrow wire cage, with doors at each end, which, when the trap is set, remain open, having a direct passage through. A platform in the centre, where the bait is placed, is connected by a spring, which, when trodden upon, releases the doors, imprisoning the rat or rats. It has been found that the trap 8 inches high gives by far the best results.

The Mysto Trap consists of a metal structure connected with a tank full of water. The bait is placed just inside the door, which closes on the entry of the rat. In order to effect its escape, the rat climbs up the cage to a hinged platform, which collapses, precipitating the rodent into the tank. The collapse of this platform automatically opens the door of the cage, and the next rat is thus enabled to enter and repeat the performance.

Barrel Trap.—This may consist of a barrel, the upper and open part being covered with brown paper, which is cut crosswise over the middle. The bait is suspended by a thin wire immediately over the centre or where the cuts intersect. The rat, in attempting to reach the bait, is suddenly precipitated into the barrel.

Amongst other traps successfully employed are the ordinary cage trap with bait hook, and with a platform connected by a spring with the door; the steel gin trap, a type generally popular with the gamekeeper; and break-back traps.

Hunting.

Hunting with dogs and ferrets is a method generally employed in country districts, about farms, hedge-banks, and other places.

Virus.

It would appear that, in many cases, the use of virus has proved very satisfactory, in some fairly satisfactory, and in others distinctly disappointing. It is probable that, in some cases, owing to improper exposure, the virus loses its virulence.

Further, it is possible that, in some cases, hasty conclusions have been arrived at before the disease, if conveyed, has had time to incubate and declare itself. Again, as in other diseases, it seems probable that many rats possess a certain degree of natural immunity, and are not affected, whilst many that are affected receive the disease in a mild form, gradually recover, and thus acquire a certain degree of immunity or protection against a second attack. Finally, the warning as to the use of poisoned baits applies equally to the employment of rat viruses, that is to say, it is important to avoid contamination by the virus of any material likely to be used for food.

The Possibilities of Aerial Photographic Surveys for Forest Purposes.*

By OWEN JONES, Chairman Forestry Commission, Victoria.

This matter is one which came under the notice of my Commission through the Institute of Science and Industry, as the result of certain suggestions by a Mr. H. E. S. Melbourne, of South Australia. As an ex-pilot myself, with some experience of aerial photography, and some knowledge of the enormous services rendered by it during the war, I was naturally attracted by the proposal, and on considering it more closely it seemed to me to be one that might well interest the present conference, and provide profitable matter for discussion.

In putting this subject before you, I can, perhaps, scarcely do better than to state the case largely in Mr. Melbourne's own words.

Photography has been used for many years on topographical surveys and reconnaissance work in mountainous countries, and has proved very successful there; but extensive use has not been made of it in level country owing to the difficulty of obtaining suitable camera stations. This difficulty has now been overcome completely by the aeroplane, and owing to the great ease and accuracy with which vertical photos. can now be taken, a purely plane survey can be carried out without having known camera stations at all. Photos. can be taken from any height, giving negatives on scales varying from 200 to 5,000 feet to 1 inch, and from these enlargements or reductions can be made at will without affecting the accuracy. With the special cameras in use, a plane surface can be photographed with absolute accuracy, but hill features are liable to be slightly distorted near the edges of the negative. This can be very largely overcome by selecting suitable view points, and by taking special photos. over particularly steep slopes. It is, therefore, possible to take a series of photographs from the same or different heights, and to join up the prints to form a complete photographic map to any desired scale. Almost any natural or artificial feature shows up on an aerial photograph, more or less distinctly, according to the light and shade effects, and very little practice is required to distinguish the different features. An airman can photograph country as quickly as he can fly over it, and as the speed of a plane, as a general rule, is anything over 60 miles an hour, it will be evident that a very wide extent of country can be covered in a very short time. The movement of the plane does not affect the photos., as during the slowest exposure (1/100 second) the plane only moves about 1 foot at the above speed. In Egypt and Palestine, complete maps were made during the war of hundreds of miles of country which was formerly quite unmapped, or nearly so, and on all the fighting fronts a great amount of detail, such as trench systems, fortifications, &c., was filled in on existing maps with an accuracy which the draughtsman cannot question.

* Read at the Hobart Forestry Conference.

From what has been done before in the way of contouring by means of horizontal photos. only, there seems little doubt that with the aid of vertical and oblique photos., which are now so easily obtainable, it would be possible to pick out very small differences in level. (I may interpolate here that this aspect is a more or less new one to me. My experience, in common with that of other pilots, is that at any height over about 2,000 feet the country below, whatever its nature, all looks flat, though with experience one can usually pick up hills and valleys when the sun is shining, especially if it is rather low in the sky. I am, of course, aware, however, that an aerial photo. will show up many things that are indistinguishable to the naked eye, and Mr. Melbourne states that by using the Bridges-Lu-Photo theodolite an accuracy of 1 foot vertical in 10 chains horizontal can be relied upon.)

After outlining the advantages of the method for such purposes as selecting a reservoir site or carrying out the preliminary surveys for railways, Mr. Melbourne continues:—A Government surveyor on subdivisional work spends, perhaps, a week in making a preliminary sketch of a new parish. Later on he or his assistant spends anything up to three weeks on sketching in intermediate details, such as belts of timber, open plains, tracks, hill features, &c., with questionable accuracy, and often loses time on road-running through not having a thorough knowledge of the country he is dealing with; whereas one flight in an aeroplane gives him a complete map to work on, of an accuracy second only to his theodolite. Having a photo.-map of the parish would not only lessen the amount of work, but would make the selection of road routes much easier and more systematic, and, in fact, enable the surveyor to classify the land and say with certainty where his roads can go within a week or so of commencing work. The old-fashioned system of laboriously sketching in pastoral and Crown land areas by means of the compass can be done away with immediately, for just as good photos. can be taken of out-back runs as of the city and suburbs. Aerial photos. would be invaluable to the valuator, whether on pastoral work or on repurchased land, in determining the exact areas of clearings, scrub, or stony country, swamp lands, or cultivation, all of which show differently on an aerial photo. The lengths of fences, drains, &c., would also be shown, and would enable such improvement to be valued on inspection without having to do any measuring up. Aerial photos. could also be used for keeping records, such as the extent of damage done by bush fires. The cost of the actual photography would not be more than a few pence per mile after the initial outlay, and this outlay should be saved over and over again on the subsequent theodolite survey.

In considering the application of aerial photography to survey work along the lines suggested by Mr. Melbourne, it is undoubted that the methods proposed would be of great value in the rapid preparation of maps and plans of large forest areas, especially with regard to the preliminary work necessary for the construction of forest working plants. To a great extent the work of dividing the larger areas into suitable blocks or compartments, of framing the network of roads and rides necessary for transport purposes, and of planning a system of breaks to check destructive fires, has yet to be carried out in our forests, and maps made by so rapid and accurate a process as aerial photography would be an invaluable aid. They would not, of course, indicate the

species, quantity, and quality of the timber on an area, information which is, as a rule, given by the ordinary ground surveyor; but this would not constitute a serious objection, as the map itself would be very speedily obtained, and with its assistance the task of the local forest or working plans officer in making the inspection necessary to supply the missing information would be greatly facilitated.

It is, however, only reasonable to point out that the initial expense of establishing the system would be very considerable, involving as it would the erection of hangars and workshops, the creation of main aerodromes in suitable centres, with a sufficient number of supplementary landing grounds, the purchase of machines, spares, and stores, the establishment of depôts for petrol oil, &c. The upkeep expenses, including replacements, care of engines and machines, and salaries of pilots, mechanics, photographers, &c., would also be no small item, although once the system overcame prejudice and inspired sufficient confidence to insure a large volume of work, the rapidity with which maps could be produced would in all probability reduce their expense to a fraction of that involved by present methods.

It might be noted, too, that forest country, especially in a hill district, is about the worst possible for pilot and machine in the event of engine-failure, and consequent forced landing. Unless a clear area were available, and the pilot at a sufficient height to enable him to reach it, the machine would almost certainly be wrecked, and the pilot very possibly killed.

It would obviously be out of the question for a forest authority, with the comparatively limited funds at its disposal, to attempt itself to inaugurate any such project, but it might be expected gladly to avail itself of the opportunity to procure plans by so rapid a means should the necessary machinery be set in motion and the plans be available at reasonable rates.

It is suggested that the encouragement of these up-to-date survey methods is chiefly a matter for Government enterprise, and certainly lies somewhat outside the province of a department which, while it finds plans and maps vital for the efficient conduct of its work, has not their production as its primary aim. I have, however, no wish to throw cold water on the scheme; on the contrary, I think the forest authorities should give sympathetic consideration to any practical suggestion as to co-operation with other Departments which, like themselves, could well utilize the results of any successful project along the lines under consideration.

In conclusion, I might suggest that perhaps some arrangement to the desired end could be made with the military authorities. Flying has become so much a matter of practical politics that the maintenance of a considerable aerial equipment in Australia would appear inevitable. This would, in all likelihood, include the provision of many of the aerodromes, landing-grounds, and depôts necessary for photographic survey work, and there should also be no excessive difficulty in arranging for the military pilots to devote a part of their time to this end. Such an arrangement would seem likely to benefit both parties, as Departments or the general public wanting plans could procure them quickly and easily, whilst the payment for them would help to reduce the cost of maintenance of the military aerial branch.

An Australian Forest Products Laboratory: Research on Forest Products.*

By I. H. BOAS, M.Sc.

THE NEED FOR RESEARCH.

There is no necessity for me to suggest to a conference of foresters the need for research into methods of utilizing forest products. Every forest service in Australia has, of course, carried out more or less isolated investigations, and during recent years one or two of the services have begun to make research a regular and increasingly important part of their programme. There may be, however, need for emphasizing the necessity for federalizing such work, and organizing it in such a way that overlap is saved and waste prevented.

So many of the problems that await solution are common to all Australia that it is manifestly absurd to attack them in various States. Take, for example, the question of distillation. Work on this has been begun in at least three States. There has been no attempt to co-ordinate the work, or conduct it on common lines. It is quite impossible even to compare the results of experiments, for some are given as yields per cord, others as yields per ton. In some cases the moisture content of the wood is given, and in others it is not. In the accounts that I have read of these experiments, there is no indication that any attempt is made to register or control temperature conditions. Now, it is wasteful to proceed in this way. Before setting out on experiments in wood distillation, it is essential, firstly, that full advantage should be taken of the accumulated experience of other places, and that a general plan of work should be laid down, with care, so that all results obtained should be directly comparable, and that all data are properly recorded. Unless this is done, much of the work may need to be done again.

What I have said in regard to Federal control applies particularly to timber-testing. I have already emphasized, in a recent article to the *Australian Forestry Journal*, the need for standardizing this work. To any one examining the work done in the various States, it is obvious that the results obtained are not by any means comparable.

In the case of kiln-drying, it is manifestly wasteful to establish various sets of experimental kilns. One bunch of kilns can work out specifications for timber, and can be run far more economically than the same number of kilns under separate control. All the experimental work in the United States is done in the small bunch of kilns at Madison. The result of the concentration of the work here has been that highly-skilled specialists are turned out to supply the needs of the trade. The same arguments apply also to the other numerous problems that are common to all forest services.

In some cases, of course, purely State problems arise. For example, it may be desired to find a use for some purely local product, such as a gum or fibre, or an essential oil. Even in some such cases there is

* Read at the Hobart Forestry Conference.

great need for unified control of the work. If the results of such investigations are to be as good as they should be, then there must be a staff of experts to carry them out. It is not possible to get a chemist who can one day attack a problem in essential oils, and next day one in tanning materials.

Now, it is quite improbable that each State would be able to employ a staff of expert chemists and physicists in each main line of investigation. The only way in which this can be done is to concentrate the work in one well-equipped and properly-staffed laboratory. Some of the smaller local problems can, of course, be handled as well on the spot, and possibly more quickly dealt with in this way. My remarks apply to all main investigations, and to those needing specialists. For both Federal and local problems, then, there is only one way to attain efficiency, and that is by the establishment of a Federal laboratory that is properly equipped to do the work of all the States. This is, of course, what is planned in the proposed establishment of a Forest Products Laboratory by the Institute of Science and Industry. There is no need to fear that the work planned by separate States will not go ahead as rapidly as if it were done locally. The method I will suggest later for the organization of the work insures a proper distribution of the work and a proper apportionment of the activities of the laboratory to the needs of all. The only Forest Products Laboratories at present in existence are those at Madison, Wisconsin; McGill University, Montreal; and Dehra Dun, India. In each case the laboratory has to serve larger forest services than in Australia, widely scattered, with divided control and very varied products. Yet it has been found necessary to federalize the research into single institutions.

Madison has one branch on the West Coast at the Seattle University, and McGill has a branch at Vancouver. These branches, however, are confined to one kind of work only, viz., the strength tests of timbers. This project is huge, and necessitates many hundreds of thousands of tests carried on over long periods. It is manifestly impossible to carry on tests on timbers from all parts of the country at the same time. It was, therefore, wisely decided to establish branches on the West Coast. The Vancouver laboratory was only established quite recently to deal with aeroplane timbers, but it is being continued, and there is plenty of work to be done there for years to come.

With this exception, all forest products research is centred in the one laboratory in each country, and there has been no sign of any dissatisfaction. To insure a proper distribution of the work, I suggest the system adopted in India. A Board of Forestry, consisting of the Chief Conservators in the various provinces, lays down the main lines of the programme for three years ahead. A similar system adopted in Australia would insure that each State would have its fair proportion of the laboratory's time, and would avoid possibility of complaint that any one State was receiving more than its due attention. In America, all working plans have to be submitted to the officer in charge of research at Washington, whose duty it is to see that every one is satisfied as far as is practicable.

How the Requirements can be Obtained.

A Forest Products Laboratory is an expensive institution. Montreal spends £12,000 a year, and its state is parlous because of lack of funds, Dehra £40,000, and Madison, during the war, £140,000. Madison has a reduced grant now, but it is still enough to keep a staff of 250 busy. Dehra is even now spending £500,000 on extensions of buildings, equipment, and staff. The present requirements for Australia for a laboratory that is reduced to a minimum are a capital outlay of £20,000 to £25,000 and a yearly expenditure of £25,000. What hope would there be of doubling this? There is great need, then, to make the best of the one Forest Products Laboratory by the united support of all the States.

The sum of money I have mentioned seems a lot to ask from the Federal Government. It can, however, I believe, be obtained if the various States will help. Let me outline what has already been done in Western Australia by the State Government and private citizens.

Firstly, a grant of 25 acres of land for a site and a sum of £5,000 towards the cost of the building has been granted by the Western Australian Government. The State Forestry Service has, from its research grant, already found, or signified its willingness to find, when the work is approved, various sums amounting to £1,100 a year as subsidy for the investigation of definite problems more or less local. In addition, the principal newspaper proprietors have agreed to find a sum of £500 for plant for testing out any Australian paper-making materials. This is purely Federal work. The Victorian Forestry Service* is also finding £150 a year towards the paper investigations, provided a Victorian material is examined. This has all been obtained in the few weeks since my return.

It is easy to see that, if similar support can be obtained from all the States, it will not be difficult, with Federal assistance, to obtain even a larger sum than I have stated as a minimum requirement. I am sure that other groups of business men can be induced to put up various sums of money for specific investigations. If the ease with which we obtained the £500 in Perth, by simply asking for it, is any indication of the fact that business men at last realize that research pays, then we need fear no trouble about funds. By pooling the possible financial resources of Forestry Departments for research, a sufficient sum should be obtainable, with Federal assistance, to enable the engagement of well-qualified specialists, and on this depends the success of the laboratory. Poor salaries will not attract the men whose work will insure success.

I think there is need to stress this point, even at a conference of specialists. Even in forestry I believe there is need for specializing in certain directions. Yet, as is common in most groups of professional men, it is not realized how far this same condition applied to other lines of work. At any rate, there appears to be a tendency to think that when a chemical problem arises all that is necessary is to hand it to a chemist. I venture to say that many of the problems in the utilization of forest products would long ago have been settled, and at great saving of money, had they been given to specialists instead of to any one who had some training and was ready to have a go.

* Queensland and New South Wales have recently promised to contribute for similar investigations.

I have been both the victim of and a principal in such bad practice, so I can speak with some authority. I know also that similar conditions apply in other States than Western Australia.

If the Forest Products Laboratory is to justify its existence, it should have on its staff at least a few highly trained specialists for a start. It will produce others as its work develops.

Scope of the Work of the Laboratory.

The general functions of a Forest Products Laboratory are well enough understood by members of this conference, but there are some aspects that need consideration. It is necessary to define the scope of the work, particularly as regards certain subjects. For example, in India the Forestry Research Institute at Dehra undertakes sylvicultural research. There certainly seems to be a necessity for some central control of this work if much overlap is to be avoided. The actual work, however, would best be done by State forest officers working to a central plan. There seems to be no need, however, to attach this to the Forest Products Laboratory, unless the various State services did unite in a scheme and wished to centre it all in one officer, who could be housed in the laboratory.

Another section of work which is carried out at both Dehra and Madison is the economic study of lumbering questions, mill scale, studies of various species, and a comparison of cost of production under various grading rules. Investigations of logging and milling practice to determine improvements in production and utilization. These and other related questions are studied in this section. However, such studies are now, and probably will remain, the province of State forestry services.

The principal lines of investigation at the laboratory would be under three main heads:—

1. Timber Mechanics and Physics;
2. Chemical Investigations;
3. Pathology.

Under the first heading would come the strength tests (1) of small clean specimens, (2) of large beams, and (3) of timber for various specific purposes, (4) of built-up structure, (5) of boxes, barrels, &c., and (6) of timber treated by seasoning or preserving. It would also include the microscopic study of timber and the relation of structure to properties, and studies in seasoning.

The chemical section would include the investigation of gums, oils, resins, and other minor products, tanning and paper studies, methods of utilizing waste, such as distillation, conversion to alcohol, &c., preservation studies, &c.

The pathology section would include studies in timber diseases and methods of prevention and cure, and also joint work with the preservation section.

Co-operation with Industries.

The laboratory should be intimately associated in as many ways as possible with the industries using forest products. If it is to succeed it must interest these industries, and to do so it must educate and serve them.

This co-operation can be brought about first by a close study of the needs of the industries and an effort to meet these needs by investigation of their difficulties. Search can be made to find materials suitable to their needs, methods of saving waste, reducing costs, or increasing efficiency developed. The results of the investigations must be made known to the industries in the way of reports, articles in trade journals, and by circulars to special industries.

The services of the technical staff must be readily available in an advisory capacity, with restrictions to prevent individuals from getting the sole benefit of such work.

Another way in which the laboratory can serve the industries is by training technical officers, who can then transfer their services from the laboratory to the factory. This, of course, must be limited. In other words, the laboratory must offer sufficient inducement to officers to prevent their being tempted out too soon or too often. At Montreal I found that the greater part of the staff had left within a few months to go into industrial positions. This, of course, prevents continuity in work, and destroys the chance of obtaining experts. The paper trade, for example, after it had taken all the paper experts from the laboratory, found that the source of its supply had been destroyed, and set to work to persuade the Government to pay reasonable salaries to the officers of the laboratory. This danger must be avoided.

Co-operation.

The general policy of co-operation must, of course, be so constructed that the laboratory cannot be used to take the place of consulting technologists. It is not desirable that this should be possible. The governing idea in other Forest Products Laboratories is that, unless something new is to be learned by an investigation, it will not be undertaken. If, however, there is no other source from which an industry can obtain advice, and where there is nothing fresh to learn, but only the application of information already established, then advice is given, but a charge is made. This charge can be reduced, at the discretion of the laboratory, to the extent that fresh information of value is gained during the course of the work. The laboratory always has in mind all such arrangements that, while it exists to assist industries, it must not be used for the exclusive advantage of any one factory or individual.

In all co-operation on an extensive scale an agreement is drawn up setting out the obligation as to payments, supply of material, reports on results in the factory, &c., by the industry concerned; and, on the other hand, the obligations of the laboratory. It is always stipulated that the laboratory shall have unrestricted right to publish the results of investigations.

In India liaison officers move about the country and study the industries. They find out what materials they need, and where they are obtainable. If an industry in any way depends upon the use of a forest product, inquiries are made to see how supplies of this may be made available, and the factories supplying this material are helped, by advice or otherwise, to produce the required amount.

The system of technical notes issued by the Madison Laboratory also helps to bring industries in close contact with its work. These notes are brief accounts of results of work done, advice to industries, &c. They are sent out monthly to the industries interested.

A further method of co-operation very successfully carried out at Madison is the establishment of classes for men engaged in industries such as seasoning, glue work, box design, &c. Short courses for operators are very popular and useful.

It may be objected that closer co-operation would result if the laboratory were in one of the industrial centres. This is not necessarily the case. The laboratories at Dehra and Madison are not in industrial centres; the former is hundreds of miles from any large town. The laboratory cannot be everywhere, and must, wherever it is, maintain its connexion with industries by means of field officers. This is the plan adopted in other places, and it has proved very successful there.

The Need for Propaganda.

There is need for a generous measure of propaganda among the industries, and the public generally, to bring home the value of research into forest products. The best results will, of course, be obtained by the achievements of the laboratory; but even these need to be well advertised, or they will not be recognised.

A research laboratory needs large sums of money. To get money, a public sentiment must be aroused. Newspaper and magazine articles will do something, and a publicity section must be established for this purpose. Much can also be done by means of cinema films illustrating various activities of the laboratory. These methods and others are widely used in America.

A model of the box-testing plant is shown in operation at exhibitions, country shows, &c. A concrete result of these methods was the solid support for the Madison Laboratory when its grant was recently threatened. The time and energy spent in propaganda were well repaid at that time.

The Laboratory and the Forest School.

I have frequently heard suggestions that the Forest Products Laboratory should be worked in conjunction with the Forestry School. There seems at first sight to be some advantages in this, but I am sure the disadvantages more than outweigh them. In America there is a certain amount of research work done at the forest schools. For example, in San Francisco, at Berkeley University, the staff of the Forest School only work two semesters, and the other half of the year is free for research. The research, however, is mainly into forestry proper. At the Seattle School there is a good deal of work on such problems as seasoning, preservation, waste utilization, &c. It was found, however, advisable to remove the research from the teaching. In India, the Research Institute was associated with schools for rangers and provincial forest officers, but it is now to be separated, and the laboratory will be moved several miles away, and all connexion severed.

It is a good thing for teachers to be engaged on some research, and there should always be such provision in a school as allows of this. It is bad, however, for a research officer to be required to teach. Experience shows that, if both are required of the same staff, the research work suffers. When, owing to lack of funds or any other cause, there is pressure on the time of the staff, the teaching work has to go on. It is not a bad idea for a research officer to give an occasional course of lectures on his specialty, but he should not be in any way responsible for the teaching work. I am, therefore, strongly opposed to the union of these two institutions. They serve separate needs, and must stand apart.

The Chalcid Parasites of Muscid Flies in Australia.*

By T. HARVEY JOHNSTON, M.A., D.Sc., Professor of Biology, University, Brisbane.

On account of the economic importance of Muscid flies—a group which includes not only the house fly or typhoid fly, but also most of the various sheep-maggot flies, or blowflies, as well as the common "bush flies" of Australia—considerable attention has been given to the study of their hymenopterous parasites, at least one of which has been utilized in New South Wales and Queensland as an agent to assist in controlling the spread of these Diptera. It has also been suggested to the Federal authorities by an eminent British entomologist that a number of species might, with advantage, be introduced from England to assist in this work.

Mr. W. W. Froggatt has done a considerable amount of work on fly parasites, having dealt with not less than three, viz., *Nasonia brevicornis*, *Chalcis calliphoræ*, and *Dirrhinus sarcophagæ*, which destroy pupæ of one or more of the sheep-maggot flies.

In this article it is proposed (1) to record observations on two species, one of which is now reported for the first time as occurring in Australia; (2) to briefly review the work on the parasites recorded as being already present in the continent; and (3) to discuss the suggestion that certain other wasps might be profitably introduced.

The following five muscid-destroying chalcids are now known to occur in Eastern Australia:—(1) *Spalangia muscidarum*; (2) *Nasonia brevicornis*; (3) *Chalcis calliphoræ*; (4) *Dirrhinus sarcophagæ*; (5) *Pachycrepoideus dubius*. The first, second, and fifth belong to the Pteromalidæ, and to the sub-families Spalangiinæ, Pteromalinæ, and Sphegigasterinæ respectively, while the others are members of the Chalcididæ. The first, second, and fifth are known from Queensland; the second, third, fourth, and perhaps also the first from New South Wales.

(1) *Spalangia muscidarum* (Richardson).

During November and December, 1919, when numbers of house flies as well as certain species of bush flies were being raised in the laboratory at Eidsvold, Burnett River, Queensland, in connexion with work on flies as transmitters of worm parasites of stock, it was noticed that in several batches the percentage of flies emerging was very low, viz., from 15 per cent. to 61 per cent. Thus, in one experiment with house flies, the larvæ pupated on 21st November, and a few flies emerged on 29th and 30th November. No more having emerged after the lapse of over a week, the pupæ were collected and counted, when it was found

* Abstract of a paper by Dr. Johnston and Miss Bancroft, published by the Royal Society of Queensland, 1920.

that flies had emerged from only 15 per cent. of them. The remaining pupæ were placed in tubes. On 15th December, several small black ant-like chalcids, averaging about 3 mm. in length, were noticed, more emerging during the succeeding days. As they appeared, the little insects were transferred to a large jar, the end of which was covered with a piece of cloth, and were fed by smearing honey and water on the cloth. Copulation was observed to occur at once, and females readily attacked fresh fly pupæ on the day of emergence.

When about to oviposit, the female walks over the pupæ, testing the surface with her long flexible antennæ. A suitable place having been found the sharp, piercing stylet connected with the ovipositor is brought into play, and a tiny hole bored in the chitin of the puparium. A few minutes is usually sufficient to effect a puncture, the stylet being thrust for its whole length into the wound.

The eggs are minute oval structures, measuring from 0.4 to 0.45 mm. in length by 0.1 mm. in breadth. The shell is minutely papillose, except at one end, which is drawn out into a blunt projection varying somewhat in length. This point is not obvious in the uterine egg. The larvæ, on hatching, is a tiny white segmented creature, which applies its mouth to the surface of the fly pupa, and gradually increases in size at the latter's expense. When the chalcid larvæ pupates, it assumes the form of the adult, the structures being, however, soft and white, and surrounded by a clear envelope. During the pupation stage, the hard chitinous cuticle of the imago is developed. When the insect is ready to leave the pupa case of its host, it gnaws an irregular hole at the anterior end and crawls out. Nothing is left of the fly pupa by this time but a dark shrivelled mass. Both sexes of the chalcid are capable of flight immediately upon emergence.

The sexes differ in the form of the abdomen, which is shorter and more spindle-shaped in the male, whereas that of the female has a prominent projecting terminal region, and in the shape of the head, which in front view is seen to be relatively broader and shorter in the male. The antennæ are also unlike.

As far as our experience goes, only one chalcid develops in each parasitized fly pupa, thus from 53 pupa cases of which individual record was kept, only 53 chalcids emerged. The size of the perfect insect depends upon the size of the pupa in which it developed. Two *Spalangia* have occasionally been seen ovipositing at the same time in one pupa. The period of time elapsing during summer (December and February) between the laying of the egg and the emergence of the wasp is between three and four weeks (21 to 28 days).

It was found that in Texas, United States of America, during the colder weather, the period ranged from 61 to 109 days, while during winter the adult did not emerge, the insect apparently overwintering in its pupa stage.

Our results show that larval development is passed through very rapidly under Queensland summer conditions. This is a factor which renders it particularly valuable as a means of controlling the spread of noxious Muscids in this State.

Pupæ of the following four species of Muscid flies were collected and examined during the summer in order to ascertain the percentage infection:—

Species.	Number examined.	Number parasitized.	Percentage.
M. domestica	76	64	84
M. Fergusoni	214	84	39
M. vetustissima	15	11	73
M. terræreginæ	83	16	73
Total ...	386	175	45

In addition to the house fly and cattle flies just mentioned, many others, including the stable fly and certain blowflies, became parasitized and destroyed while in the pupal condition.

(2) *Nasonia brevicornis* (Girault and Sanders).

The first record of the presence of this tiny chalcid in Australia was made by A. Girault in 1913, who discovered it in Brisbane in 1911. It was first bred out from a sheep-maggot fly by E. Jarvis (1913), who obtained it from Central Western Queensland. In 1914, W. Froggatt called attention to the parasite as one which was destroying the pupæ of various blowflies, including the main sheep-maggot fly. In conjunction with his son and T. McCarthy, he published accounts of its habits, and also of the work done at the experimental station in New South Wales, where the insect was bred up for widespread distribution as a means for controlling blowfly infestation of sheep. Similar work, controlled by the Institute of Science and Industry, has been in progress for a considerable time near Roma, Queensland.

Mr. Froggatt reported that from 2 to 75 of these wasps had been bred from parasitized blowfly pupæ, the usual number being between 25 and 26. The maximum number found by us was only 18, the usual number being about 9 or 10.

(3) *Chalcis calliphoræ* (Froggatt).

This chalcid was described from the Hay district of New South Wales by Mr. W. Froggatt in 1916 as a black wasp, about the size of a house fly, with reddish-yellow antennæ, oval shining red-brown abdomen, and with thickened hind legs. It is a hardy species, which breeds readily in captivity, a single insect killing and emerging from each parasitized pupa. The insect attacks one of the blowflies while the latter is in the active maggot stage, and apparently does not prevent its pupation before death.

(4) *Dirrhinus sarcophagæ* (Froggatt).

This rather large chalcid (6 mm. long), which is about the size of a large house fly, has been recently described by Mr. Froggatt (1919) as parasitizing the pupæ of the "common flesh fly" (*Sarcophaga aurifrons*). It has highly modified hind limbs, which are used to enable the wasp to burrow into the loose soil to reach the pupæ lying an inch or more below the surface.

(5) *Pachycrepoideus dubius* (Girault and Sanders).

This chalcid parasite, belonging to the Pteromalidæ, was recorded by Girault in 1913 as having been caught on windows at a number of North Queensland localities. It was originally described as a housefly parasite in United States of America. No doubt it attacks and destroys various flies in Queensland.

Remarks on certain other Hymenopterous Parasites capable of controlling the spread of Flies, and which might be utilized in Australia against "Sheep-maggot Flies."

Graham-Smith, in two excellent papers containing his observations on the habits and parasites of common flies in England (1916, 1919), has published interesting information regarding the Hymenoptera which attack fly pupæ or larvæ, ultimately destroying them. The most important as fly-controllers seem to be *Alysia manducator*, *Aphæreta cephalotes* Hal. (both belonging to the Braconidæ), and *Melittobia acasta* Walker (Chalcididæ).

Alysia manducator.—Graham-Smith's observations on this relatively large Braconid, which is as long as a house fly, show that it is fairly common in England, parasitizing as many as 83 per cent. of fly pupæ collected at certain times, especially during autumn. He stated that—"These facts reveal the extraordinary destruction wrought by these parasites, and indicate that larvæ feeding in warm and sunny situations are more liable to attack than those living in shady places." The female, which lives only a few days in confinement, attacks and oviposits in larger living larvæ, not waiting for them to pupate. In one experiment, this author found that a female deposited eggs in at least 206 out of 544 larvæ provided; that 80 other larvæ died, possibly due to infection caused by the insertion of the ovipositor; and that no less than 343 eggs were still contained in the wasp's ovaries. "Under more natural conditions, it is likely that she would have infected a greater number, as the ovaries contained at least 549 eggs." This wasp overwinters as a pupa, emerging in the spring. Its habits should make it a very desirable insect for use against sheep-maggot flies in Australia.

Aphæreta cephalotes (*Hal.*).—This is a much smaller Braconid, being only half the length of the preceding wasp. From each parasitized blowfly pupa a number (7 to 14) of these insects have been bred out. The species appears to prefer sunny situations for oviposition, small larvæ being selected for the purpose. It passes through the winter while within the fly puparium. From the information available, it does not seem to be as valuable a fly-controller as the preceding species (Graham-Smith, 1916, 1919).

Melittobia acasta (Walker).—This is a tiny Braconid, whose habits are described in an interesting account by the same author. There is a very marked sexual dimorphism, the males possessing rudimentary wings and eyes, as well as peculiarly modified antennæ. The female can live in confinement for a long period (33 to 36 days—95 the maximum noted), and lay up to 300 eggs. The males are short-lived, and do not leave the puparium in which they have been developed.

This remarkable insect also parasitizes the larvæ of solitary wasps, as well as the pupæ of a Tachinid fly, which itself parasitizes wasps. It is thus both a parasite and a hyperparasite. Graham-Smith (1916) reported that it was not only a parasite of fly pupæ, but acted as a hyperparasite towards the above-mentioned Braconid *Alysia*. *M. acasta* is "capable of causing an immense amount of destruction. If it is usually a hyperparasite on the Braconid larvæ, it is not an insect to be encouraged, since it kills off large numbers of parasites very destructive to flies; if, on the other hand, it usually attacks fly pupæ during the summer months, it is most beneficial, its powers of destruction being so great; if, lastly, both Braconid and fly larvæ are commonly parasitized, its beneficial action is somewhat neutralized."

In view of the above statement by such an authority as Graham-Smith, and in view of the fact that it is capable of parasitizing Tachinid flies and solitary wasps, which may be of considerable economic importance in controlling various insect pests, it would probably be unwise to introduce into Australia such a form as *M. acasta* as an agent for controlling the spread of flies.

Dibrachys cavus, another chalcid, seems to be of value as a parasite of fly pupæ, but little information is available to us regarding it.

The contents of this article may be summarized as follows:—

1. There exist in Eastern Australia at least five hymenopterous parasites which destroy flies (including sheep-maggot flies) namely, *Spalangia muscidarum*, *Nasonia brevicornis*, *Chalcis calliphoræ*, *Dirrhinus sarcophagæ*, and *Pachycrepoideus dubius*.

2. Of the various hymenopterous parasites known elsewhere as destroying fly pupæ, three others appear to be of outstanding importance, viz.:—*Alysia manducator*, *Aphæreta cephalotes*, and *Melittobia acasta*. The last-named acts also as a hyperparasite of many useful insects, and should not, in the light of our present knowledge, be introduced into Australia. The other two could apparently be safely introduced, if desired, to assist those parasites already present. The first-named seems to be especially valuable in this connexion.

The Shark for Food and Leather.

By ALLEN ROGERS, Pratt Institute, Brooklyn, N.Y.*

From time immemorial the shark has been considered as an enemy to man and as a scavenger of the sea. He has been pictured as the cannibal of the deep, and in fiction has been painted as the monster who lurks about the ill-fated ship in order to devour the unfortunates who may have met their death in the gale or on the reef. We, therefore, for generations have cherished an antipathy for this creature of the sea, and have been very willing to accept as fact all of these stories, never stopping to consider that perhaps, after all, the shark might have a few points in his favour.

To begin with, the shark does not live exclusively on the flesh of man. In fact, there are only a few species who would eat human flesh, even if it were possible for them to secure it. The principal species considered a man eater, the tiger shark, probably has seldom had the pleasure of this delicacy. Sharks, like all other fish, live on the smaller fish; thus upholding the proverb that the big fish eat the little ones.

Sharks travel in schools, or singly, and are found most abundant where food fish are plentiful. They are especially fond of the mullet, menhaden, mackerel, and sea trout. Thus it will be seen that they are migratory, and at various seasons are found in different waters. They are naturally warm-water fish, which accounts for the large number found in the Gulf of Mexico, along the coast of Florida, and the West Indies. Being rapid and powerful swimmers they often follow ships for hundreds of miles picking up food as it is thrown over the side of the vessel. Thus their diet at such times is not unlike that of our domestic hog and poultry. It is claimed by fisher folk that the shark will not eat unsound food, which shows him even more particular than our friend the porker. Why, then, if he is so clean in his habits of life, should we discriminate against him?

The Bureau of Fisheries for several years has endeavoured to interest the people of this country in using shark meat as an edible product, with a certain amount of success. In fact, that species of shark known as dog fish is being canned in large quantities and sold under the name of gray fish. Certain fisheries on the New England coast are removing the head, tail, and fins, and selling the product in Boston and New York as deep-sea sword fish. In Boston, also, shark meat is being sold as such to the Italian trade, who appreciate its food value and enjoy its delicate flavour. Why, then, should we not take a lesson from the Italians and acquire the shark-eating habit?

For the past five or six years the writer has been interested in developing a method for converting shark skins into a merchantable leather. As a result of this work several processes have been devised which have been assigned to the Ocean Leather Company operating fisheries at Morehead City, N.C., and Fort Myers, Fla. This concern

* From *The Journal of Industrial and Engineering Chemistry.*

alone expects to get up to a catch of 1,000 fish daily, although at present they are not taking this number. The skins are now being manufactured into leather, the livers rendered for their oil, and the flesh converted into fertilizer stock. It is estimated also that at least 1,000 sharks can be secured daily from the fishermen handling food fish, who at present simply kill the sharks getting into their nets and throw them back into the water. By this wasteful procedure on the part of the fishermen at least 1,000 sharks daily are destroyed along the Atlantic coast. Thus, not only is the skin lost to the leather trade, not only is the liver oil discarded, not only is a large amount of fertilizer material made unavailable, but at least 50 per cent. of the weight of the shark, which would be fit for human consumption, goes to waste.

A conservative estimate, based on the above figures, indicates that for a catch of 2,000 sharks daily, at an average weight of 200 lbs., there would be 400,000 lbs. of fish. As at least 50 per cent. could be used for human consumption we would have 200,000 lbs. daily, or 73,000,000 lbs. annually. Assuming that the market price could be set at 10 cents we have a saving of $7,300,000.

The question of supply is one that is constantly being asked. From personal observations, and those of men who are most familiar with the subject, it seems evident that the supply is inexhaustible. Another question is often raised as to the best method to prepare the flesh for market. The answer is, cold storage. This method, however, may not always be practical in isolated fishing stations; recourse must then be made to salting, smoking, or drying. The fresh meat, however, is the most delicious, and when boiled, broiled, or baked furnishes a white, flaky food, closely resembling halibut or sword fish.

A source of food supply so extensive warrants our most careful consideration, and it is hoped that the time is not far off when we may overcome our prejudice and take advantage of Nature's abundant supply.

The Cattle Worm-Nodule Parasite.*

Some Experiments with Flies as possible Transmitters.

By Professor T. HARVEY JOHNSTON and M. J. BANCROFT, Walter and Eliza Hall Fellow in Economic Biology, University, Brisbane.

Although a considerable amount of work has been carried out by various Australian investigators with a view to ascertaining how cattle become parasitized by *Onchocerca gibsoni*, Cleland and Johnston—the organism which produces "worm nodules"—we are still ignorant as to what is the transmitting agent. The prevailing idea is that a Tabanid fly is responsible, though a number of workers, including Cleland, Breinl, Hill, McEachran, and others, have used such flies unsuccessfully.

March Flies.

We have attempted to infect various March flies in the Upper Burnett River district, Queensland, during 1918 and 1919, by allowing them to feed on freshly-cut living worm nodules. Of course, one must admit that this is quite an unnatural method as far as the transmitter is concerned, since most of the embryos or larvæ liberated from the female by this means are probably not in a fit state to commence their development in the intermediate host, though some would, no doubt, be ready to do so.

The species used were *Tabanus circumdatus*, *T. australicus*, *T. mastersi*, and *T. dubiosus*. Though they were examined at intervals varying from one to ten days after such feeding, no development of the larvæ taken up by them had occurred, and in only one case was a living larvæ found in a fly's alimentary canal one day after feeding. The tissues of each fly were carefully examined, and, though certain other filarial worm larvæ were found, no trace of *Onchocerca* was detected.

On account of the presence of *Onchocerciasis* in local cattle, it was thought that an examination of captured Tabanids might yield information. Five hundred were caught and carefully searched between November, 1918, and January, 1920, but the results were negative, though, as already stated, another parasite, *Agamofilaria tabanicola*, Johnston and Bancroft, was detected in nearly 4 per cent. of the specimens of *T. circumdatus* examined. This is by far the commonest local March fly. Specimens of *T. australicus*, *T. mastersi*, *T. cyaneus*, and *T. dubiosus*, were also searched for the presence of worm parasites, but without success, the numbers examined being, however, comparatively few.

* Abstract of a paper by T. H. Johnston and M. J. Bancroft, "Experiments with certain Diptera as possible transmitters of bovine *Onchocerciasis*." Proc. Royal Soc. Queensland, 32, April, 1920, p. 31.

"Cattle Flies."

On account of their association with the eyes, nose, mouth, and injured surfaces of cattle, we carried out an examination of captured "cattle flies," and also attempted to artificially infect some by allowing them to feed on freshly cut living nodules.

The following numbers of native Muscid flies, belonging to species commonly associated with cattle, were used at various times in attempts at artificial infection, but with negative results:—313 *Musca Fergusoni*, Jnstn. and Banc.; 61 *M. vetustissima*, Walker; 41 *M. terræreginæ*, Jnstn. and Bancr.; 79 *Fannia* sp. Both bred and captured flies were used, and were dissected from 1 to 26 days after having fed on a cut nodule. Though larvæ were occasionally found alive in the alimentary tract one day after feeding, they could commonly be found dead for periods up to the fourth, and sometimes the sixth, day. In no case had further development occurred.

In addition to the above, over 1,700 captured flies were examined between November, 1918, and January, 1920, for the presence of parasites, viz.:—1,176 *M. Fergusoni*; 280 *M. vetustissima*; 21 *M. terræreginæ*; 259 *Fannia* sp. In no case was *Onchocerca Gibsoni* found, though certain other nematode worms were detected, especially the young stages of species of *Habronema* (*H. muscæ* and *H. megastoma*) which infest the stomach of horses. *Habronema* sp. occurred in the three species of *Musca* referred to, the percentage of infected flies being respectively 2.2, and 5 and 5. Another larval worm, *Agamospirura muscarum*, Johnston and Bancroft, was met with in the same three species, the percentage being respectively 6.8, 1.4 and 5. A third nematode parasite, *Agamonema fanniæ*, Johnston and Bancroft, was found occasionally in *Fannia* sp. (1.5 per cent.), *M. Fergusoni* (.4 per cent.), and *M. vetustissima* (.3 per cent.).

The investigators previously referred to failed to produce infection by using another Muscid fly—*Stomoxys calcitrans*. Hill and McEachran used the buffalo fly, *Lyperosia exigua*, as well, but without success. Cleland also employed *Musca vetustissima*, but with a negative result.

It seems to us that the various cattle flies, excepting possibly the two biting species just mentioned, are not likely to be the normal transmitting agents. Unfortunately, work with Tabanids has not so far proved promising.

Onchocerca bovis.

We would like to draw attention to the presence of a second species of *Onchocerca*—*O. bovis*, Piettre—in Australian cattle, our material coming from Queensland. Certain species of *Onchocerca* reported from New South Wales belong almost certainly to the species. The female of *O. bovis* occurs, in a more or less tangled state, in the connective tissues of the neck ligament and in the stifle joint, while the male lies free in the tissue spaces in the vicinity of the female. Typical nodules are not usually formed, though the tissue surrounding the female may become fibrosed so as to form tunnels. The lesions are not very obvious, especially when compared with the nodules produced by *O. Gibsoni*. *O. bovis* occurs in cattle in France, in North and South America, and elsewhere.

Personal.

PROFESSOR J. DOUGLAS STEWART.

Scotland has contributed greatly to the elevation of the veterinary profession, and has been the training ground of many distinguished professors and practitioners. Australia has benefited materially by the liberal educational facilities which that country has provided, and our Universities and other educational institutions owe it primarily to the Scotch colleges that instruction in veterinary science has been well founded here. The name of Professor J. Douglas Stewart, of the Sydney University, may be cited as a case in point. He is but one of very many who has advanced the knowledge and the status of the profession in the Commonwealth.

Professor Stewart was educated at the Sydney Grammar School. Afterwards proceeding to Edinburgh, he gained, in 1893, the diploma of the Royal College of Veterinary Surgeons. He also gained a number of prizes at the Royal (Dick) Veterinary College. His studies abroad revealed exceptional ability, and were rewarded by gold medals for veterinary medicine, veterinary surgery and obstetrics, pathology and helminthology, the Dick Bursary for highest marks in various class competitions throughout the curriculum, Third "Fitzwygram" prize, and the Highland and Agricultural Society's medal for best essay read and defended before the Veterinary Association of the College. It is of interest to note that the subject of the essay was "Diseases of Australian stock."

Upon returning to Australia, Stewart practised with his father in Sydney for several years, and gave a great deal of time to teaching, and to work of a semi-public character. He acted as lecturer at the Sydney Technical College, and was honorary veterinary surgeon to the Zoological Society of New South Wales. In 1898, New South Wales was threatened with invasion by the cattle tick, and he was then appointed veterinary surgeon to the Department of Agriculture. Becoming associated with Dr. Frank Tidswell, Government Microbiologist, an immense amount of work was done in connexion with a scientific investigation of tick fever and protective inoculation. Responsible duties then fell upon him in quick succession. Some of his appointments were adviser to the Chief Inspector of Stock on quarantine methods and procedure; representative of New South Wales at numerous Inter-State Conferences; and in connexion with the framing of regulations under the Commonwealth Quarantine Act governing the introduction of imported stock.

In 1907, Stewart was appointed Chief Inspector of Stock for New South Wales, and, two years later, accepted the invitation of the Senate of the University of Sydney to fill the recently established Chair in Veterinary Science. Professor Stewart then visited the leading veterinary schools and colleges of Great Britain, and of Europe, and obtained the most modern equipment for his veterinary schools.

Professor Stewart has taken a keen interest in military matters for a number of years, and he holds the commission of major in the A.A.V.C. He offered for active service at the beginning of the war, but was retained for home service, and acted as Director of Veterinary Services, Central Administration, during 1916-17. Since his appointment as a member of the Executive Committee of the Institute of Science and Industry in 1917, he has taken an active part in matters relating to investigations into stock diseases in Australia, and has done an immense amount of work in an honorary capacity to advance the interests of the Institute.

Reviews.

Outlines of Economic Zoology, by Professor Albert M. Reese, of West Virginia University, pp. 13 + 318, with 284 illustrations. P. Blakiston's Son and Co., Philadelphia. This book should have a wide range of readers, for although written primarily for students undergoing a regular elementary course in general zoology, it should prove of deep interest to all lovers of natural history. The author has successfully kept the economic aspect in mind in the groups he has discussed without subordinating the scientific value of his work. The fourteen chapters deal with fourteen separate orders, any one of which, because of its direct relationship with human life, constitutes a fascinating story. In the chapter on protozoa, for instance, there are short but highly interesting statements on several genera which are parasitic in all classes of vertebrates up to man. The porifera, or sponges, constitute another story of endless variety. Arthropoda, pisces, reptilia, and mammalia are economically, perhaps, of most direct interest, and the pages on these orders abound with stories of human interest and descriptions of scientific value. The perusal of Professor Reese's little volume will certainly stimulate an appetite for further study of the subject.

SOME PUBLICATIONS RECEIVED.

The Journal of the Department of Agriculture of Victoria (April).—A series of articles by Mr. A. E. V. Richardson, M.A., B.Sc., on the "Wheat campaign" deal comprehensively with wheat and its cultivation.

The Forest Flora of New South Wales, Vol. VII., Part III., by J. H. Maiden, C.V.O., F.R.S., F.L.S.

The Journal of the Department of Agriculture of South Australia.—Mr. W. J. Spafford, Superintendent of Experimental Work, publishes the results of a series of experimental plots which were laid down in flax (linseed) for seed.

Journal of Agricultural Research, Vol. XVIII., No. II.—W. W. Garmer and H. A. Allard discuss the effect of the relative length of day and night and other factors of the environment on growth and reproduction in plants.

Bulletin of the School of Mines and Metallurgy, University of Missouri, Vol. IV., No. 3.—Comprising a bibliography on the roasting, leaching, smelting, and electro-metallurgy of zinc.

Journal of the Franklin Institute, Vol. 189, No. 3.—Dr. E. W. Dean, in an article on motor fuel, gives information regarding (*a*) the production and use of gasoline, (*b*) marketing of gasoline, (*c*) physical and chemical properties of gasoline, and (*d*) present tendencies in the development of substitutes for gasoline. The relative merits of field glasses are discussed by the Sub-Committee of the National Research Council.

Queensland Agricultural Journal (April).—Principal articles:—"A Clean Milk Supply," by R. B. Tennent, deals with milk-borne diseases, and general treatment to prevent contamination; "The Banana Weevil" (*Cosmopolites sordida*) is described by Mr. Henry Tryon; and "Cane Grub Investigations" are reported on by Dr. J. F. Illingworth.

New Zealand Journal of Agriculture (March) deals with the incidence locally of "Take-all" in wheat, milk and cream for factory supply, and the control of red mite on apple trees.

Photo by "Broothorn" Studio.

MR. DAVID AVERY, M.Sc.

A leading industrial chemist, and a member of the Executive Committee of the Institute of Science and Industry.

(For Biographical Notes, see page 377).

SCIENCE AND INDUSTRY.

VOL. 2.] JUNE, 1920. [No. 6.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

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Fuel Economy and the Carbonization of Coal.

SINCE the Industrial Revolution coal has been, is now, and will remain, the chief source of energy for heat and motive power. His modern rival—mineral oil—is strictly limited in supply. The world's production of coal is over 1,200 million tons a year; that of crude oil about 75 million tons, or less than 10 per cent. of the heating power of the coal.

Moreover, the reserves of coal are more than 7,000,000 million tons, or about 6,000 times the annual consumption; whereas the petroleum reserves are only 5,000 million tons, or a little over 60 times the present consumption per year. It is estimated that 469 million tons of coal were used in the United States alone, in 1917, for steam-raising. The most conservative estimate of coal used by ocean-going ships annually cannot be less than 60 million tons, equal to 40 million tons of fuel oil; and, since not more than one-third of the crude oil produced at the well is available for ships, it will be impossible to convert even all the ocean-going tonnage to the use of oil-fuel, if petroleum wells are to remain the sole sources of supply. As will be seen later, however, coal is destined in future to play a much more important *rôle* in oil production than it has done hitherto. The many advantages of oil-fuel—its compactness, ease of transport, flexibility in use for heat,

light, or power—are so fully appreciated that demand will continue to outpace supply until soaring prices impose the economic limit to its employment.

If it is admitted that coal must continue to be our main source of energy, it will be granted also that it has been wasted in the past; yet the particular improvements to be adopted are subject to acute controversy. It is apparent that great economies are practicable by superseding the multitude of small steam plants in existence by large central power-stations generating and distributing power electrically over urban areas. For such large stations, most engineers are agreed that the steam-turbo generator has quite outdistanced the gas-engine in size of units, capital, and running costs and reliability. At the same time, it should be noted that by combining waste-heat boilers feeding turbines with the gas-engine exhaust the thermal efficiency can be raised to 25 per cent., as against 18-20 per cent. for the largest size of steam turbines.

A further point of controversy relates to the practice of direct coal-firing of boilers. It has been frequently asserted that great economies are possible by first carbonizing coal, as in gas-works practice, recovering valuable by-products, using gas for direct heating, and producing steam for electricity generation from the coke residue. The most authoritative report on these modes of utilizing coal for the needs of a large power-station with 100 per cent. load-factor is that of the Nitrogen Products Committee. Their conclusions may be summarized thus:—

1. Carbonization of coal—as practised in gas-works or coke-oven works—or, alternatively, the complete gasification of coal in producers (with ammonia recovery), offers no immediate prospect of reducing the cost of electrical energy from coal below that obtainable by direct-firing of boilers.
2. The main hope of cheaper power from coal appears to reside in the carbonization of coal at a low temperature, but a successful commercial type of plant has not been in operation.
3. In the present state of the art, the employment of gas-engines for large-scale power production is not economical; for moderate blocks of power, however, up to (say) 6,000 kilowatts, the gas-engine can easily compete with steam-turbo plant of corresponding size.

The above report was written in 1918. Meantime, circumstances have arisen which will force reconsideration of carbonization and gasification of coal in relation to fuel economy.

Along with increasing demands for motor spirit and fuel-oils—with corresponding stiffening of prices—the yields of oils obtainable by modern methods of carbonization of coal have almost doubled within that period. We are within sight of an economical method of producing still larger quantities of such oils from coal, together with a respectable gas production. Besides this development, processes are emerging for the complete gasification of coal in a single operation to produce gas

almost free from inert constituents, and of a thermal efficiency in the process approximating 80 per cent. When the full bearing of these apparently contrasting but really complementary systems of carbonization comes to be realized, conclusions (1) and (2) of the Nitrogen Products Committee will require re-statement.

Large-scale electricity generation and supply involves often long-distance transmission of current to the areas of distribution. It is curious that the alternative of transmitting gas under high pressure has received so little attention from engineers, although it is possible to show that, for equal bulks of power delivered, the capital and transmission costs are smaller for high-grade gas than for high-voltage current, whilst gas has two advantages peculiar to itself, viz.:—(i) It can be stored comparatively cheaply at the distribution end; and, therefore, when—as usual—the load-factor fluctuates, a much smaller generating plant is necessary for gas than for electricity. (ii) Gas can be distributed for direct heating at a cost of not more than one-third that of electricity. It is unfortunate that, whereas statistics of motor-power installed in a given area are usually available, records of the consumption of fuel for direct heating are entirely lacking; it is probable, however, that the fuel requirements of a city for direct heat are not less than one-half of the total fuel used for motive power, including electric lighting and heating. This is a point which requires careful consideration in any scheme involving the transmission of big blocks of power derived from coal over long distances.

The key to the position in the immediate future is to be sought in the unlimited demand for fuel-oils and motor spirit, the inadequacy of supply from the oil-fields, and the prospect of their early exhaustion. Oil from shale and industrial alcohol will come into requisition; but, in view of the bulk and world-wide area of supply, the world will learn in future to look more and more to coal to supply its need of fuel oils. This will lead to the establishment of large carbonization industries on the coal-fields. The surplus gas, supplemented by gas directly produced by complete gasification of coal, will be piped under pressure to cities for distribution or for power generation. Solid fuel will not thus be entirely displaced, but the coke residue of the carbonization process —either as such or in the form of briquettes or pulverized fuel—will take the place of raw coal for power generation and heating industrially and domestically.

Coal prices have risen rapidly in recent years; but, if the forecasts above made are sound, it is of the utmost importance that the public should realize that every check to economical production of raw coal, or unnecessary increase in its price, involves a heavy tax on the community and an abridgment of its wealth.

R. E. T.

EDITORIAL

RESEARCH AND INDUSTRIAL DEVELOPMENT.

A Bill has recently been introduced in the House of Lords to prevent dumping, and to establish a Special Industries Council to advise as to the promotion and assistance of special industries.

The provisions of the Bill, which are of special interest in connexion with industrial research, are contained in those sections which deal with the establishment of the Special Industries Council. The special industries which the Bill seeks to promote and assist originated in great measure through the war, and are enumerated in the Second Schedule of the Bill. They are defined to be industries supplying commodities which are essential to the national safety—as being absolutely indispensable to important industries carried on in the United Kingdom, and which formerly were entirely or mainly supplied from outside countries. They cannot be said to be firmly established as yet; some of them, like the manufacture of synthetic dyes, have made extraordinary progress, and their permanence is only a question of time; others are being developed with more or less rapidity; but every one of them is the subject of continued scientific inquiry and research, and it is the purpose of the projected measure to foster and protect them during this period.

To this end, the Bill provides for the creation of a Council of not fewer than five and not more than nine persons of commercial and industrial experience to be appointed by the President of the Board of Trade. Its duties will be to watch the course of industrial development, and, in consultation with the Department of Scientific and Industrial Research, to advise the Board of Trade as to the promotion and assistance of special industries. The Council will be required to examine applications or proposals for the promotion, assistance, better organization, or management of any special industry, and to advise the Board of Trade as to what steps, if any, should be taken to conserve or promote any special industry.

SCIENCE AND DEFENCE.

The British memorandum of the Secretary of State for War relating to the Army Estimates for 1920-21 is a notable document in both its national and scientific aspects. It represents the introduction of a new attitude towards military and medical science, as is shown by the following quotations:—"We must continue to develop the power of our armaments, not by accumulating large stocks of weapons and stores for a great national Army in peace time of patterns that may become obsolete before they are used, but by scientific research and experiment, which will lead to the design of the best types, and by preparation, which will enable bulk production to commence without

the unfortunate delays that had such a lamentable effect during the early stages of the Great War. . . . It is necessary to make adequate provision for research experiments and design in connexion with war material. . . . We must, unfortunately, continue our studies of what is known as chemical warfare. . . . It is our policy to farm out to civil scientific institutions, such as the Universities, the National Physical Laboratory, the Imperial College of Science and Technology, &c., all pure research that can be profitably farmed out, and, generally speaking, to restrict military institutions to applied research and the preliminary design of apparatus." Commenting on the above, *Nature* points out that there is reason for hope in improved conditions. It is undeniable that, broadly speaking, early in the war the Army was perilously out of touch and out of comprehension with respect to science, but it must also be remembered that the forces of science were not marshalled and led by any means so well as they might have been. No doubt, wonders were done during war time, but it is most desirable that for the future science should have some scheme of mobilization ready.

SCIENCE AND THE NAVY.

A Department of Scientific Research and Experiment has been established under the Controller of the British Navy. As scientific adviser to the Controller, and in charge of the Department, there has been appointed a Director of Scientific Research, who is responsible for the general direction and organization of research work for naval purposes, keeping the Navy in touch with outside scientific experiments, and insuring that the work at the various naval experimental establishments dealing with mines, sound signals, and navigational appliances proceeds with full cognisance of scientific progress and methods. In order to carry on the work of the Department, a small Naval Research Institute is to be established adjacent to the National Physical Laboratory at Teddington. This Institute will be entirely controlled by the Admiralty, but its close association with the National Physical Laboratory will offer exceptional facilities for co-operation, and the scientific staff of the Institute will have the advantage of first-hand acquaintance with the work being carried out at the Laboratory.

INDUSTRIAL RESEARCH IN ITALY.

Italy was not long in following the lead of the other European countries in establishing a national department for the prosecution of scientific and industrial research as a means of post-war reconstruction. The necessity for such action has been made more urgent by the adoption in many industries of an eight-hour day. Necessarily, increased efficiency in manufacturing methods must be brought about if production is to be maintained. Otherwise, she would be unable to meet competition from other nations whose industries are more highly organized. According to a report by the United States Trade Commissioner at Rome, four stations have been established—two at Milan, for paper and fats respectively; and two at Naples, for leather and ceramics. Another is being established at Reggio, Calabria, for essential oils and perfumes, and three more are to be established as follows:—At Rovigno,

for the sugar industry, in connexion with the existing school of beet culture; at Milan, for the development of the refrigerating industry; a third, probably at Rome, to study the distillation of gases and their by-products, and, in general, all the processes of combustion. One section of this last-named station will devote itself to the question of the utilization of national fuels and lignite. Later on consideration will be given to the creation of stations, on the initiative of the manufacturers, for the electro-technical and photo-technical industries, and for dyestuffs. In order that the standard of vocational education might be raised, provision was made, at the end of 1918, for the establishment of laboratory schools. At first, there will be twenty of these schools, of which two will be at Milan. In addition to a Government subsidy of 25,000 lire each, the laboratory schools will receive appropriations from the local authorities and the obligatory support of the manufacturers. The schools established during the war at Turin, Milan, Genoa, Modena, Florence, Rome, Naples, and Palermo will be transformed into laboratory schools. Provision will also be made for the ordinary industrial schools, in all of which short courses of study, both practical and theoretical, will be instituted.

CO-OPERATION BETWEEN SCIENTIFIC AND INDUSTRIAL EFFORT.

Professor W. H. Walker, of the Massachusetts Institute of Technology, has introduced a scheme which he terms "The Technology Plan" for facilitating the introduction of technical research to the manufacturer, for making the application of science to industrial problems popular, and for creating an appreciation on the part of the leaders of industry of the value of science and the necessity of providing for its continued growth and development. The essential feature of the plan is an agreement between individual industrial organizations and the Institute, under which the industry pays an annual retaining fee, in return for which the Institute assumes definite obligations.

In explaining his scheme, Professor Walker draws attention to the fact that the great demand of the industries to-day is for men properly trained to solve the many problems with which the industries are confronted. This requires, first, a knowledge of the principles of science; and, second, training in the application of this knowledge to the solution of the ever-recurring difficulties. For this purpose a student must spend an additional year or more in a research laboratory in post-graduate study. The first point of co-operative contact in the plan is, therefore, that the Institute agrees to take up for its research work such problems as are submitted to it by persons engaged in industry, and thus to be in a position to maintain a steady stream of trained men constantly flowing into industry with the best preparation for scientific work which it is possible for it to give. The Institute also agrees that if an industrial organization has special technical problems requiring extended consultations, investigations, or research work, it will advise the organization where and by whom such services could best be rendered. The Institute also provides for conferences between members of its staff, research workers, and the officers of industrial organizations, and thus to furnish a method by which the research

staff is enabled to profit by contact with men of affairs and receive the inspiration which comes from the capitalization of effort. The plan appears to be meeting with great success; already 190 agreements for research have been made, and a Division of Industrial Co-operation and Research has been set up to handle them.

POWER FROM THE TIDES.

The British Cabinet, it is announced on high authority, has had before it preliminary plans prepared by the experts who are inquiring into the possibilities of utilizing water-power in the United Kingdom for generating electrical energy for the construction on the Severn, close to the new high-level bridge which the Great Western Railway proposes building, of a huge dam, in the centre of which would be a free space for the escape of the imprisoned tidal water, thus providing the power. The Cabinet has given instructions for further preliminary stages of the project to be undertaken. It is interesting to note in this connexion that a power-station is about to be erected on the Mersey to supply the Liverpool and Birkenhead area, and that a project is on foot to utilize the water-power of the Dee, from Llangollen downwards, in the electrical development of North Wales. Discussing the Severn proposal, a leading South Wales engineer ventured the opinion that the harnessing of tidal-power could only be solved by interlinking the big waterways and making use of the difference in the times of the tides. "From a private enterprise point of view," he continued, "it would be cheaper to produce electricity by means of coal, for the capital outlay would be tremendous. Such a scheme, when it comes, must be a great undertaking, and should be run on a national basis—not the estuaries of the Severn and Wye only, but every waterway that has any storage capacity. There is a big difference of tide between the Severn, Mersey, and Forth, for example, and if you could harness and link together these estuaries it would be a good thing, for it would stabilize the ebb and flow. This would require very careful calculations, and would have to be undertaken after close study of the tides and the various channels. The other means is by storage in accumulators at a terrific cost. There must be a storage capacity of practically the full output of the station, for at the turn of the tide the plant would be absolutely useless." "Before any tidal-power scheme is a financial success," said Professor Frederick Bacon, A.M.I.E.E., Professor of Engineering at the South Wales and Monmouthshire University College, Cardiff, "you must have some economical and cheap means of storing electricity. At present, the recognised method of storing energy during the time of high tide, when you can get no power, is by pumping water into a high reservoir, and the capital necessary is absolutely prohibitive unless the natural configuration of the district has special facilities to offer. If a scheme for the use of tidal-power were put forward, Chepstow would be a good place to start, for a 40-ft. tide is not to be found in many places; but the capital cost would be very great, and I doubt whether it could be economically worked."—*The Electrical Review.*

STANDARDIZATION IN BUILDING INDUSTRIES.

The housing problem, which is intimately related to the high cost of living, industrial unrest, and degenerating influences on the moral fibre and physical well-being of a nation, was one of the main subjects discussed at the first annual meeting of the United States of America National Federation of Construction Industries, held at Chicago last March. Special attention was directed to the subject of standardization and quantity production, and the Federation proposes to work out the standardization of materials, building practices, and business usage. It is not intended to carry the idea so far as to restrict the exercise of initiative and individuality in architectural design, but it is believed that there is room for considerable uniformity in the sizes of materials and the dimensions of component parts of buildings; for example, uniformity in the dimensions of doors, window frames, staircases, and the placing of studding and joists, would not restrict architectural expression. It was also pointed out that standards of size would permit manufacturers to keep their plants operating continuously instead of being forced to produce intermittently according to the flow of specific orders. Engineering as well as commercial standardization will be given attention by the Federation, and in this connexion the United States Bureau of Standards, the American Society for Testing Materials, the American Engineering Standards Committee, the Division of Engineering of the National Research Council, the United States Bureau of Mines, and the American Institute of Architects, all of which were represented at the Convention, have offered their co-operation.

THE BRITISH DYE INDUSTRY.

The effort made in Great Britain during the early days of the war to recapture the German dye trade is being well sustained, and is meeting with substantial success. At a meeting of the Bradford Dyers' Association, a month or two ago, it was pointed out that, whereas before the war not 10 per cent. of the aniline used in the United Kingdom were made in that country, and the total weight manufactured did not exceed 2,000 tons a year, the production now was 25,000 tons a year. These figures show an excess of the total weight of aniline dyes consumed in Great Britain immediately before the war. Up to the present, however, the variety is more or less restricted, and some of the best colours are lacking. In the February number of *Science and Industry,* Lord Moulton was quoted as having stated, so far as the United Kingdom was concerned, there was no dye of any importance which could not be made when the plant was available. Increase in range, however, was not the sole objective. Quantity as well as quality had to be supplied. Last year, the value of dyed and printed textiles exported reached a total of £181,990,350, and the total weight of aniline dyes imported from all sources amounted to 3,234 tons, of the value of £1,826,574. When it is remembered that the industry had to be built from practically no foundation the results reflect the greatest credit on the scientific power of the chemical industry. While the British dye makers are struggling for the efficiency attained by the German chemical works, the Manchester Chamber of Commerce is giving the lead to a movement for securing a State subsidy.

WOOLLEN RESEARCH ASSOCIATION.

During its first year, the British Research Association for the Woollen and Worsted Industries has developed into one of the largest research associations in the United Kingdom. The number of firms which at first banded themselves together for the promotion of scientific investigations has more than doubled within less than two years. The subscriptions to a central fund had similarly increased from £2,980 to a minimum annual contribution of £6,163. This amount entitles the Association to a grant of nearly £6,000 a year from the Department of Scientific and Industrial Research, so that already about £12,000 a year is available for research, apart altogether from special donations and interest. The textile industry comprises about 2,000 firms, and it is hoped, according to the annual report of the Association, to soon embrace the whole of these. The Department of Scientific and Industrial Research has already agreed that for each additional £1 over and above the sum of £5,000, and not exceeding £8,000, raised by the Association in respect of any one year of a five-year period, a sum of 10s. will be payable. For each additional £1 over £8,000 raised by the Association in respect of any one year of the period a further sum of 5s. will be payable, provided that if, and when, the total income of the Association from the subscriptions of members and the grant from the Government in any one year reaches the sum of £50,000, the rate and amount of any further grant shall be the subject of special negotiation. The first step taken has been the renting of premises where "chemical and physical laboratories, a simple mechanical workshop, a controlled temperature and humidity room, microscopic and photographic room, library and council room, offices, and store rooms will be fitted out." The report adds that "We have now got our organization together, and the coming years will see the establishment and extension of a service of co-operative research, centred in the Association, which will devote its energies primarily to scientific investigation in connexion with the production of wool and its uses in industry; and, further, to the carrying out of private inquiries, at the request of individual members, with the object of raising the general status and efficiency of the industry as a whole."

THE CONTROL OF OIL SUPPLIES.

Addressing an audience of business men in Manchester recently, Sir Edward Mackay Edgar said that the position of England to-day regarding oil was curious, states *The Oil and Colour Trades' Journal*. The United States, owing to having made so much money during the war, developed the oil position to such an extent that this year there would be 8,000,000 motor cars in the United States, and these would use 80 per cent. of the world-oil spirit. The United States oil supplies would only last them fifteen years, and then they would get their oil from us. A few years ago, England controlled 15 per cent. of the oil position of the world, now we had got 50 per cent. of the visible oil supplies. He was perfectly satisfied that inside of ten years the United States would be paying 1,000,000,000 dollars for oil alone. He could see no way out. We dominated the position in Central America and South America.

On the other hand, Sir J. Cadman, Professor of Mining at Birmingham University, in a lecture at the Royal Institution on "Petroleum and the War," said that only 2 to 4 per cent. of the world's oil supply is in the hands of this country. "One cannot overlook the fact," he remarked, "that the United States, with 66 to 70 per cent. of the world's oil supply, is in a very strong position, but at the same time we must not forget that they are developing at such a rate that they are absorbing oil at a greater rate than ever. There are 6,000,000 motor cars flying about in the United States, besides a great fleet of steamers, and when their shipping scheme is completed they will have 1,730 ships burning oil. With our own limited oil supplies it is essential that the keenest activity should be shown in stimulating every supply of petroleum and its substitutes. I believe that we shall be able to secure supplies, although our present source in the West may only be able to provide us with diminishing quantities." The lecturer further said that the output of the United States was 60,000,000 tons, compared with the 70,000,000 tons of the rest of the world, towards which Europe contributed only 5,500,000 tons.

Speaking at a luncheon held in connexion with the exhibition of motor-boat, &c., engines at Olympia, Sir Hamar Greenwood said that one of the tragedies of the war was the shortage of fuel, which kept many warships inactive. The Admiralty were the pioneers in considering the use of oil as fuel, and at this moment we were the most advanced country in the use of oil-fuel for ships and vehicles, except, perhaps, America for land vehicles. The tragedy was that only 2 per cent. of the oil that came into this country was produced under the British flag, and 80 per cent. came from the United States and Mexico. He wished he had the power to make the wells in which they were now experimenting in England gush out millions of gallons a month. He could assure them that the Government and the Department over which he presided were fully alive to the vital necessity of oil and more oil under the control of the British flag. There was not a single part of the world which was open to prospectors where oil was not being sought, and great efforts were being made to secure oil-fields where the oil could be controlled from the source to the consumer by the British Government. The possibility of producing oil from coal and all the other suggestions were being examined by eminent men. One great system was held up by the fact that we had not enough coal. We were not yet in a position to use coal for making fuel, but he hoped that before the year was out a commercial plan would be submitted for doing this, for the demand for oil must grow from day to day.

FUMIGATION WITH LIQUID HYDROCYANIC ACID.

Liquid hydrocyanic acid, which was first used as a fumigant on a commercial basis in 1917, has rapidly come into favour as an insecticide in California. In the January issue of *Science and Industry* results were published showing that under a test the most marked killing effect with the liquid form is at the bottom of the tree, while with the pot or portable generator the greatest toxicity is at the top. Investigation has found that the greatest possible yield is 108 lbs., or 18.56 U.S. gallons of anhydrous liquid hydrocyanic acid from 200 lbs. sodium cyanide (51.52 per cent. cyanogen). The amount of liquid hydrocyanic

acid (95-98 per cent.) that has been recovered during the past year has been about 78 per cent. of the total available. The amount of gas evolved by the pot or portable generator is estimated at 90 per cent. of the total available gas. During 1918, so the latest reports indicate, 75 per cent. of the gas from a given amount of cyanide in the liquid form was made to cover the same ground as 90 per cent. from the same amount by the ordinary methods of generation. Thus, while there has been a discrepancy of 10 or 15 per cent. in the actual amount of gas used through the liquid method, the results in the field have not indicated any important difference on the scale insects experimented with. Information regarding the physical and chemical properties of liquid hydrocyanic acid in the meantime is being accumulated at the Agricultural Experimental Station of the University of California, and it is confidently anticipated that the yield in the future will be equal to, or even greater, than that now obtained from portable generators.

EUROPEAN CORN BORER.

The maize-growing industry of United States of America has for some time been threatened by the European Corn Borer (*Pyrausta nubilalis*), which has obtained more than a foothold in one or two important corn States, but the expenditure of large sums of money and the rigid enforcement of quarantine restrictions has, up to the present, prevented the rapid spread of the pest. For the last two or three years the United States Bureau of Entomology has been advocating most thorough repressive measures, and the agricultural and technical press has been urging the strictest precautions. Failure on the part of the Federal Government to follow the advice of its scientific officers has not only negatived the splendid work already done, but it has involved the growers in severe losses, and has enormously increased the work to be done. In a report recently issued by Dr. Howard, Chief Officer of the Bureau of Entomology, he states that much good work was done in 1918 in preventing the extension of the borer in 1918, mainly under State appropriations; but, in 1919, the requisite Federal appropriation was not granted, with the result that, by August, the moth had spread over an area of 1,000 square miles. Other publications to hand of recent date refer to a conference held at Albany and Boston to prepare a scheme for the extermination of the borer. This conference was held by the National Association of Commissioners of Agriculture, and it passed a resolution that the most energetic efforts on the part of the Federal and State agencies should be made to control, and, if possible, exterminate the pest, including rigorous quarantines to prevent its distribution. It was urged that Congress should make an appropriation of 4,000,000 dollars for the current year to carry out this work, and for this purpose a committee was suggested, representing the Commissioners of Agriculture, official entomologists, and the Plant Pest Committee.

POTATO WART UNDER CONTROL.

In the war against potato wart, the United States has done in less than two years what other countries had not succeeded in doing in decades. Wart has been for a long time a destructive disease of potatoes in Europe, and the belief always was that, once a garden or field

became infected, there was no way of eradicating it. An infected area, even when no potatoes were planted in it for a number of years, would show the disease still virulent when again planted to potatoes. The potato wart disease was discovered last year in gardens in some small mining towns in Pennsylvania. The United States Department of Agriculture quarantined the infected areas, and the specialists of the Department began experiments in control. They have now announced that a field or garden infected with potato wart can be thoroughly disinfected by the use of steam and formaldehyde. The cost of the work, however, is high, and it will be used only when absolutely necessary in cleaning up the infected areas. The investigators of the Department, who have worked in co-operation with the State authorities of Pennsylvania and West Virginia, have also discovered varieties of potato that are immune to the wart disease, and steps are being taken to assist gardeners in the infected regions to purchase varieties of seed known to be immune. The Department specialists now believe that further losses from the disease can be practically eliminated.

CATTLE TICKS GIVEN NO REST.

Preparations are under way in the tick-infested southern States of United States of America for active resumption in the spring of the campaign against the destructive cattle parasite. Last year's plan of beginning dipping operations as early as possible in March will be followed this year. In fact, it is expected that the early dipping this year will largely surpass anything done in previous years. Thus the cattle tick will be killed before he has a chance to acquire a large and active family. In some sections, where weather conditions made it possible, dipping has been kept up through the winter, and the costly little insect has been given no rest in the season when it has been customary to suspend active field work. An area of 219,581 square miles remain to be freed from the domination of the tick. Officials of the Bureau of Animal Industry, United States Department of Agriculture, are confident that a large slice of this area will be taken out of quarantine as a result of the 1920 campaign.

THE OUNCE OF PREVENTION APPLIED.

Cotton-planters, states an official publication, already fighting the boll weevil all the way from New Mexico to the Atlantic Ocean, and threatened by the pink boll worm, which occasionally gets across the Rio Grande, are not to have any more alien enemies on their hands if the United States Department of Agriculture can prevent it. Importers recently have insisted upon bringing in a considerable quantity of cotton seed from Porto Rico. The seed may be free from disease, or it may not be. Nobody has very accurate or thorough knowledge of infecting insects and pests of cotton in Porto Rico. So, before admitting the Porto Rican cotton seed, the Department of Agriculture is going to make a thorough investigation of the subject. A specialist has been commissioned to go to Porto Rico and make a study of cotton insects on the island. His report will enable the Department to be certain whether or not cotton seed from Porto Rico is in any way a menace to the cotton interests of the United States.

EDITORIAL.

INDUSTRIAL RESEARCH IN GREAT BRITAIN.

The following is a list of Research Associations which have been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research, and have received licences from the Board of Trade under Section 20 of the Companies (Consolidation) Act of 1908:—The British Boot, Shoe, and Allied Trades Research Association, Technical School, Abington-square, Northampton. Secretary—Mr. John Blakeman, M.A., M.Sc. The British Cotton Industry Research Association, 108 Deansgate, Manchester. Secretary—Miss B. Thomas. The British Empire Sugar Research Association, Evelyn House, 62 Oxford-street, London, W.1. Secretary—Mr. W. H. Giffard. The British Iron Manufacturers' Research Association, Atlantic Chambers, Brazenose-street, Manchester. Secretary—Mr. H. S. Knowles. The Research Association of British Motor and Allied Manufacturers, 39 St. James's-street, London, S.W.1. Secretary—Mr. Horace Wyatt. The British Photographic Research Association, Sicilian House, Southampton-row, London, W.C.1. Secretary—Mr. Arthur C. Brookes. The British Portland Cement Research Association, 6 Lloyd's-avenue, London, E.C.3. Secretary—Mr. S. G. S. Panisset, A.C.G.I., F.C.S. The British Research Association for the Woollen and Worsted Industries, Bond-place Chambers, Leeds. Secretary—Mr. Arnold Frobisher, B.Sc. The British Scientific Instrument Research Association, 26 Russell-square, W.C.1. Secretary—Mr. J. W. Williamson, B.Sc. The Research Association of British Rubber and Tyre Manufacturers, c/o Messrs. W. B. Peat and Co., 11 Ironmonger-lane, E.C.2. The Linen Industry Research Association, 3 Bedford-street, Belfast. Secretary—Miss M. Burton. The Glass Research Association, 50 Bedford-square, W.C.2. Secretary—Mr. E. Quine, B.Sc. The British Association of Research for Cocoa, Chocolate, Sugar Confectionery, and Jam Trades, 9 Queen-street-place, E.C.4. Secretary—Mr. R. M. Leonard. The British Non-Ferrous Metals Research Association, 29 Paradise-street, Birmingham. Secretary—Mr. E. A. Smith, A.R.S.M., M.Inst.M.M.

Schemes for the establishment of Research Associations in the following industries have reached an advanced state of development:—

Research Associations Approved by the Department, but not yet Licensed by the Board of Trade.

The British Music Industries Research Association. The British Refractory Materials Research Association. The Scottish Shale Oil Research Association. The British Leather Manufacturers' Research Association. The British Launderers' Research Association.

Proposed Research Associations whose Memorandum and Articles of Association are under Consideration.

The British Electrical and Allied Industries Research Association. The British Aircraft Research Association.

Industrial Organizations Engaged in Preparing Memorandum and Articles of Association.

Silk Manufacturers. Master Bakers and Confectioners. Cycle and Motor Cycle Manufacturers. Users of Liquid Fuels.

In addition to the industries included above, certain others are engaged in the preliminary consideration of schemes for forming Research Associations.

DEHYDRATION OF MILK.

A paper on the above subject was read at a recent meeting at Birmingham of the Society of Chemical Industry by Colonel J. G. Wright, of Toronto. Colonel Wright prophesied that before ten years have elapsed we shall be purchasing our domestic milk supply by the pound at the grocery store instead of having it delivered in liquid form. The product now obtained by several processes is sufficiently good to allow the preparation of a fluid bearing a fairly close resemblance to fresh milk, or, at least, to heated or cooked milk.

Discussing methods, Colonel Wright stated that in one process two hollow metal cylinders, arranged to revolve in opposite directions, are mounted so as almost to touch each other. The cylinder performs about fourteen revolutions per minute. The cylinders are heated internally by steam, so as to have a surface temperature of 100 degrees C.; the milk is first evaporated in vacuo to about one-quarter by volume; it is then pumped to the elevated containers over the cylinders, and is allowed to flow between; the concentrated milk spreads in a thin film over the surface when the cylinders have completed one half-revolution, and the film of dried milk is scraped off and powdered in a powdering mill. In another process largely used in Canada, the milk is evaporated in vacuo; then the evaporated milk is forced through fine needle points under pressure into a chamber containing hot air, when the powder falls to the bottom, and does not require to be put through a powdering mill. Each of these processes requires a high degree of heat, and occupies about one hour to complete. The new process, which is to be used at St. Thomas' Factory, Toronto, consists of two cells or chambers built of hollow tyle lined with tin. Each cell is 28 feet high by 21 feet square. At the top of the cell, in the centre, is the spray; it consists of two circular discs about 16 inches in diameter, and placed 1¼ inches apart. Around the outer edge are placed a number of teeth. The sprayer was made to revolve by a 5 horse-power motor at 4,500 revolutions per minute. The milk is fed in by gravity, and sent out in a centrifugal spray, which is very finely divided. In the cell are sixteen openings, four on each side, to allow hot air to enter the cell. These openings are 4 feet long by 5 inches wide. The air is drawn from the outside through washers, and passed over furnaces driven by a 10-horse motor-power fan. On the walls of the floor level are placed exhausts. The milk passes from the receiving station to the top of the first cell, and in passing through the latter 75 per cent. of the water is removed. It falls and flows out at the bottom into a container as concentrated milk. From this container it is pumped up to a second cell, where the operation is completed; the balance of the water is extracted, and the milk flows to the bottom in powder, where it is caught by a fan and blown immediately into a cooling chamber on top of a sieve, through which it falls into a storage bin. Two cells have a capacity of 50,000 lbs. raw material each day, and were operated by three employees. The author pointed out that in the new process the milk never comes in contact

with heat greater than 160 degrees F., and the butter-fat globules are not broken up. Consequently, the resulting powder will keep indefinitely. The process retains all the food elements of the original milk, and the reconstituted milk does not have a "cooked" taste. Colonel Wright stated that butter of good quality had been made from milk powder which had been kept for two years. Dried milk is not germ-proof, but the number of bacteria is small compared with the number in ordinary cows' milk.

Samples of newly reconstituted milk were handed round for the examination of the chemists.

CARBON DIOXIDE AND INCREASED CROP PRODUCTION.

In 1912, at the International Congress of Chemists, held in New York, a suggestion was made that crop production might be increased by increasing the concentration of carbon dioxide in the air. Of course, the idea underlying such a suggestion is that since the carbon dioxide of the air is a necessary constituent in the synthesis of carbohydrates by the plant; and since, furthermore, the percentage of the gas in the air is comparatively small, any increase in the amount of carbon dioxide may tend to increase the amount of carbohydrate produced.

That such is actually the case is stated by a writer in *Science* (7th May, 1920). According to a Berlin correspondent of the New York *Tribune*, a number of German chemists have carried out experiments in greenhouses attached to one of the large iron companies in Essen, utilizing carbon dioxide, freed from impurities, obtained from blast furnaces. In this way, the yield of tomatoes was increased 175 per cent., and cucumbers 70 per cent. Further experiments in the open air on plots round which punctured tubes were laid, and through the latter of which the carbon dioxide was sent, are reported to have given increases of 150 per cent. in the yield of spinach, 140 per cent. in tomatoes, and 100 per cent. in barley.

SCIENTIFIC DEVELOPMENT OF PACIFIC ISLAND RESOURCES.

As the result of various informal conferences in America, a Scientific Congress has been organized to meet at Honolulu, from the 2nd to 20th August, 1920. The purpose of the Congress is to outline scientific problems of the Pacific Ocean region and to suggest methods for their solution, to make a critical inventory of existing knowledge, and to devise plans for future studies. It is anticipated that this Congress will formulate for publication a programme of research which will serve as a guide for co-operative work for individuals, institutions, and governmental agencies.

Representative scientists from the countries whose interests in whole or in part centre in the Pacific will be present; and a number of men, whose researches demand a knowledge of the natural history of the Pacific Islands and shore lands, have expressed their intention to attend. The programme of the conference is in the hands of the Committee on Pacific Exploration of the U.S.A. National Research Council. Mr. H. E. Gregory, Bernice Pauahi Bishop Museum, Honolulu, Hawaii, has been appointed Chairman of the Congress.

In view of Australia's extensive interests in the Pacific, the Executive Committee of the Institute of Science and Industry recommended to the Prime Minister that the Commonwealth should be represented at the conference.

RESEARCH LABORATORIES IN THE UNITED STATES OF AMERICA.

Among the most recent additions to the industrial research laboratories of America is the new Pittsburg Station of the Bureau of Mines. Although the buildings have been used on war work during the past year or two, they were only formally opened in October last. The new buildings, which are in close proximity to the Carnegie Institute of Technology, the University of Pittsburg, the Mellon Institute, and the Carnegie Library, comprise several departments, of which the more important are described in the *Chemical Trade Journal*, as follows:—

(1) Chemical and physical laboratories, for general research connected with mining and metallurgy. (2) Coal and miscellaneous analytical laboratory. For several years the Bureau of Mines has published the results of its investigations into the composition of American coal and the fusibility of ash. Another important study is that of the rock dust in mine atmospheres, which is the chief cause of silicosis or miners' consumption. (3) The gas laboratory. This department analyzes samples of mine atmospheres from all parts of the United States, with a view to improving mine ventilation and reducing risks of explosion. It also analyzes flue gases and products of combustion, natural gas, and various industrial gases. The apparatus installed includes the Burrel-Haldane device for determining the composition of mine air to within 0.01 per cent. accuracy, also the Burrell methane indicator. There is also complete apparatus for gas liquefaction and fractional distillation. When America entered the war, this department did valuable work in forming the nucleus of the American gas warfare organization. (4) Gas mask laboratory. This, of course, is closely associated with the preceding department. Tests will here be made of commercial gas masks. During the war-gas investigations certain evil-smelling and non-poisonous gases were produced, and these have now found a useful peace-time application as danger-signals in mines. Among other items in the research programme of this department is the production of carbon black by the combustion of natural gas. At present, the difficulty is to increase the yield (about 3 per cent.) without reducing the quality. (5) By-product coking research laboratory. This deals, among other things, with coal conservation and smoke abatement, the recovery of valuable by-products from coal tar, forming the basis of the dye industry and others, utilization of lignite, manufacture of briquettes, &c. (6) The petroleum laboratory will analyze the different grades of petroleum and petroleum products, and endeavour to evolve the best methods for rapid and accurate analysis. (7) The explosives department will concern itself with a complete investigation of all kinds of explosives, detonators, fuses, &c., used in mines.

EDITORIAL.

PROPERTIES OF GLUES.

Report No. 66 of the United States Advisory Committee for Aeronautics is devoted to the subject of glues used in aircraft manufacture, and, as a result of a series of experimental and other investigations, it sums up the properties of five different types of glue as follows:— Animal glue, the properties of which are familiar to woodworkers, is used as a standard for comparing the other varieties. The higher grades of animal glue possess great strength and reliability, and, in general, glue of this type flows freely and does not stain fancy veneers. No other glue is considered to be equally satisfactory for hand-spreading on irregularly-shaped objects. The chief features limiting its use are its high price and the fact that it is not very resistant to water. Casein glue is of comparatively recent introduction. Its strength is equal to that of medium-grade animal glues; it is used cold, and can be applied with a brush, but its most valuable feature is its high water-resisting property. On the other hand, casein glues have a tendency to stain thin veneers, and, in some varieties, the working life is relatively short. Vegetable glues have been widely used in recent years on account of their low cost. They are used cold, and remain in good working condition without decomposition for many days, but they are too viscous to spread by hand, and are not water resistant; they also have a tendency to stain thin fancy veneers. Blood albumin glue has shown high resistance to water, especially in the boiling test. This property makes it suitable for the manufacture of plywood, which is intended to be softened in water and moulded to shape. It is possible to make very cheap blood glue for the production of medium or low-grade articles, and it can also be made in the form of a dry tissue, the glueing then being effected in a hot press. In this form, it would appear to be very useful for laying fancy veneers, since the troubles due to moisture changes usually experienced would be avoided. The disadvantages in connexion with the use of blood glues are the expensive apparatus required, the relatively low production of the presses, and the fact that they are only suitable for glueing comparatively thin pieces. In strength, blood glues are about the same as vegetable glues, and both varieties are approximately the same as, or, if anything, slightly weaker than, medium-grade animal glues. The properties of liquid glues are, in general, similar to those of animal glues, and some brands give joints of equal strength. Their great advantage is that they are purchased in prepared form ready for immediate use, and this feature renders them very convenient for small jobs. Liquid glues, however, are expensive, and this fact, together with their poor water-resisting properties, tends to limit their use. Another drawback is the difficulty the user has of distinguishing between good and bad brands, the latter being very weak and unreliable. Altogether, it appears from the foregoing notes that none of the glues referred to is so far superior to the others as to be suitable for universal application. Evidently, the properties of each variety must be considered in relation to the purpose for which it is to be employed. Further information as to the sources, properties, methods of manufacture, methods of applying, and methods of testing the glues above referred to is given in the report, which is entitled "Glues Used in Airplane Parts."

INDUSTRIAL STANDARDIZATION.

The idea of establishing international standards in industry is rapidly gaining ground, and in one branch of industry at least—Electro-technology—a set of standards will shortly be published which have been accepted by the industrial representatives of the principal countries of the world. Few people realize the importance attaching to this work of standardization, and the difficulties that have beset the path of those who have taken upon themselves the task of bringing into line not only the divergent points of view of the various industrial factors inside each individual country, but the frequently diametrically opposing interests of the big manufacturing States of the world. The greatest difficulty is experienced in this country of getting our manufacturers to appreciate the fact that the progress of standardization is going to be of great value to them in the end. They do not seem to be able to remove themselves far enough from each particular little problem to see the whole structure of industry in its proper perspective. Their attitude may be contrasted with that of the American manufacturer by saying that their constant thought is, "How shall I best please my board of directors?" whereas the American attitude is, "How can I best give my customers what they want?" "We deliver the goods" has become the watchword of the American manufacturer, and their success in many fields of industry is due to the spirit of this remark. The American manufacturer, for instance, realized some ten or fifteen years ago that what his public required was a cheap, but really serviceable motor-car to appeal to the professional man with his comparatively small income. In other words, he proceeded to "deliver the goods," with the result that these goods have now found their way, not only into the home markets of the professional man, but into the life and industry of the whole world.

It may appear that all this is without weight in the question of deciding upon international standards, but to this country it is of the greatest importance possible. Every manufacturer in this country, for instance, knows that American car makers have adopted as their standard screw-thread throughout the whole of their products that of the S.A.E., or Society of Automotive Engineers; and in deciding upon the international standard screw for this purpose, it is scarcely to be expected that the American manufacturers—who turn out over 2,000,000 cars a year—will agree to abolish the standard which has become very generally adopted in their country in favour of one which happens to be in use on this side of the Atlantic, with an output of less than half-a-million cars per annum; but it is extremely probable that, in the very near future, a settlement of the question will be arrived at between England and America which will fix the standard screw-thread to be used conjointly by England and America, and this will go far to deciding for the rest of the world what standard it will adopt. The main tendency in striving after industrial standardization should be a unifying and not a creative one. The various factors in industry must be persuaded to come together and put up initial proposals for standardization in their various branches; and these proposals must be criticised by experts, and referred back for final adoption by the particular industries concerned. The mistake in the past has been that experts only have been appointed, and these experts have, in many

cases, worked out entirely new units, which they have attempted to force upon industry. The result in one country was that, in one particular case, a set of standards was decided upon by the committee appointed, and handed on to the industries concerned as the official lines to be followed. Instead of following these lines, the industries in question simply nodded their heads, put their hands in their pockets, and looked the other way, and not one of them ever used the standards that were fixed. It is not the drawing up of standards which is difficult, it is persuading people to adopt them; and it is here that the fact must be recognised that it is pointless to treat the industries which are to use these standards with suspicion and contempt. They must be treated with a spirit of encouragement, and requested to bring forward their own suggestions for standardization, and in this way, the manufacturers who do not adopt the suggestions put forward by their fellows will gradually realize that they will be unable to stand out. One by one they will adopt the standards, and those who do not will inevitably suffer. It is here that the British Engineering Standards' Association is doing such good work. It is encouraging practical men, right down at the very basis of industry, to form amongst themselves standardization committees, and to submit their suggestions to experts for comparison and possible adoption, and when the worker himself brings forward proposals which are accepted, no fear need be entertained that the enforcement of these standards will meet with opposition on his part.—"Engineering and Industrial Management."

POWER ALCOHOL.—RECENT PATENTS ON MIXED FUELS.

During the year 1919, the United States alone are credited with having produced 1,900,000 road-motor vehicles driven by liquid-fuel engines; the total production of the world was hardly less than 2,500,000. Allowing each vehicle an average fuel supply of 400 gallons per annum, some 15,000,000 tons of crude oil were probably wanted for road-motor propulsion. The total production of crude oil had risen from 50,000,000 tons in 1912, to 75,000,000 tons in 1919, and now represents, in weight, more than one quarter of the British coal production. The claims of agriculture are nowhere disregarded at present, and the farmers' demand for motor vehicles will increase. How is the demand to be met? The problem is by no means new; the general public is interested, and progress has been made. The prejudice against alcohol and other petrol substitutes has been overcome; power alcohol enjoys official patronage. But, owing to its low thermal value, and its low vapour pressure, alcohol is not an ideal automobile fuel,* and as long as the volatile hydrocarbons known as petrol were readily available, there was little necessity in this country to encourage the use of either alcohol alone or of mixtures of alcohol with other material. Yet, to judge by the Patent Office records, alcohol in some form or other is universally assumed to be a constituent of the motor fuel of the future. In his paper on "Recent Patents on Mixed Fuels," read before the Institution of Petroleum Technologists last Tuesday, 17th February, Dr. W. R. Ormandy restricted himself to British patents, for two

* This statement refers only to the use of alcohol as a fuel in existing types of petrol engines.—Ed. *Science and Industry.*

reasons—because the field was sufficiently wide, and because he wished to do something towards preventing the Patent Office from further granting patents on the admixture of every conceivable burnable organic liquid which might possibly be used as a motor fuel, patents which would form the seeds for future patent litigation.

The new patent regulations require the opponents of a patent to point to some publication, or some technical paper or document, and Dr. Ormandy had prepared his paper with the object of supplying such a document. He quoted the patents by numbers, not by names. The meeting certainly agreed with him that much of the patent literature since 1913—time had not allowed Dr. Ormandy to extend the present search further back—is barren, and some positively puerile. Many of the proposals he mentioned read like recipes from cookery books; others, like the addition of amyl acetate (of fruity smell) to petrol, look like attempts at evading the petrol tax. Although it was known by 1870 that ordinary—*i.e.*, ethyl alcohol—will mix with paraffin hydrocarbons, provided water be absent, and that the vapours will burn in engines, the mixing of anhydrous alcohol and petrol was patented in 1913. Other inventors got over the water difficulty by stipulating that the alcoholic mixture, prepared by the fermentation of peat with kerosene, should contain fusel oil (amyl alcohol); or they recommended the addition of various combining agents. To raise the vapour pressure of ethyl alcohol, ether was added. In the Natalite,* which is used extensively in South Africa, India, Australia, Papua,* and in other sugar-growing countries, alcohol and ether are mixed in about equal proportions, and half per cent. of ammonia, or of trimethylamine (from the sugar), are further added to mitigate corrosion. As regards the admixture of gases, Dr. Ormandy could quote some wild suggestions—hydrogenerations of already saturated hydrocarbons with acetylene by bubbling or by compressing the acetylene at 12 atmospheres, &c. That an extraordinarily wide range of chemicals can, if necessary, be used in internal combustion engines, Dr. Ormandy had recently again learnt in Berlin, where special winter and summer fuels had to be introduced during the war. The difficulty is to find the raw material for alcohol. Cellulose is not easily converted into sugar and alcohol, and sugar is too valuable; but the Ford works are said to have been successful quite recently with sawdust and straw. Yet, Dr. Ormandy was amply justified in lodging a protest against the further issue of patents on mixtures of petrol with benzol, alcohols, ether, acetone, &c., mixtures tried over and over again with the aid of carburettors and pre-heaters, and against interfering with the legitimate development of a big industry.—(*Engineering*, 20.2.1920.)

* Natalite is not used in Australia or Papua.—Ed. *Science and Industry*.

The Paper-Making Qualities of Bagasse.

The firm of Arthur D. Little, of Cambridge, Mass., was engaged by the Hawaiian Sugar Planters' Association, in 1917, to make an investigation of the paper-making qualities of Hawaiian bagasse, and the results of their experiments are now published as a Bulletin, No. 46, of 51 pages, Agricultural and Chemical Series, of the Experiment Station, Honolulu, 1919. The economic as well as the technical conditions affecting the proposed use were studied in detail, and the results obtained are strictly in line with the researches made a few years ago in connexion with the Cuban bagasse.

It was desired to establish the paper-making value of the bagasse, to compare a few of the principal varieties of cane grown in the islands, and also to determine, if possible, the effect on the paper-making qualities of the mechanical treatment to which the cane had been subjected in the mill.

Preparation of the Bagasse.

Bagasse (or, as it is often known as megasse) is the crushed cane stalks after the extraction of the juice. As it comes from the mill it is unsuitable for pulp making on account of the high content of non-fibrous cellular tissue or pith which in itself has no paper-making value, and constitutes an impurity which must be removed. This is done by shredding finely and then sifting in a rotary screen, by which process all of the pith can be removed, together with some of the finer fibre. In the investigations on Cuban bagasse it was found possible to make this separation at a very low cost. No doubt was entertained that such an operation could be carried out on Hawaiian bagasse cheaply and efficiently, but the Hawaiian bagasse appears to require finer shredding than the Cuban. In addition to being without value as a paper-making material, the pith, if retained in the pulp during the manufacturing processes, imparts various undesirable characteristics to the resulting paper.

During cooking the hot alkali partly hydrolyses the pith, so that the finished paper that contains it has a tendency to hardness and translucency. The pith also produces a gelatinous or greasy pulp in the subsequent mechanical manipulation. A greasy pulp not only gives much trouble in running on the paper machine, but causes the paper to be laid more or less translucent and to possess poor folding qualities. If not removed, the pith also produces a discolouration of the paper, which is difficult to remove. Therefore, the pith should be separated before cooking. If separated after cooking there is a needless consumption of alkali and a reduction in the charging capacity of the digesters.

One section of the report deals with the many attempts that have been made to use bagasse for paper making. This gives the various processes that have been patented. The failure of most of the attempts are due to a lack of comprehension of the characteristics of bagasse as a paper-making material, or to an attempt to convert it into a grade of paper to which it inherently was ill-adapted. In the first instance two factors which operate against it are its large bulk and relatively low yield of fibre, *e.g.*, spruce yields 51 per cent. of fibre by the sulphite process, and a cubic foot of loosely packed dry chips weighs 10 lbs. Bagasse yields 30 per cent. of fibre, and a cubic foot of bagasse containing 20 per cent. moisture and loosely packed weighs 3 lbs. In other words, 1,000 cubic feet of digester capacity would yield from each cooking 5,100 lbs. of spruce pulp as against 900 lbs. of bagasse pulp. This objection is reduced if the pith is removed from the bagasse before cooking. The yield is then increased to about 45 per cent.

In the Cuban experiments the bagasse had been prepared by the Simmons shredding process. The cane was shredded as it came from the field, then dried, reducing the moisture from 75 per cent. to 7 per cent., and next passed into a rotary screen, which allowed the pith to pass through, but retained the fibre. Each had then to have the sugar extracted separately. The process now favoured is to shred the bagasse and screen it. The Searby shredder as used in some of the experiments is not sufficient for Hawaiian bagasse. One method tried was a "beater separation." The bagasse was reduced in an ordinary paper mill beater, and the pith separated in a washing cylinder consisting of a hexagonal box faced with 12-mesh wire and scoops on the inside. The cylinder is mechanically driven and caused to revolve, so that a portion of the hexagonal box is always submerged in the pulp. The pith and water pass through the wire and are removed. Dirt, *i.e.*, sand, grit, and similar matter, char, and bark, unless well screened, is likely to produce discoloured and faulty paper, and has been the cause of much trouble with the small-scale experiments. For large-scale separation the methods are not yet sufficiently tested and worked out. Grinding and shredding and screening through a rotary screen as carried out by the Simmons process, but after the crushing, bring about the separation of the pith and fibrous portion. The moist green bagasse screens readily, and drying does not seem to be an essential operation.

Samples Used for Investigations.

In the Hawaiian experiments, four samples were used:—

1. Bagasse from "Yellow Caledonian" cane. The milling machinery which prepared the bagasse did not include a Searby shredder. 2. Bagasse also from "Yellow Caledonian" cane. The preparation included shredding by a Searby shredder. 3. Bagasse from variety "Hawaii 109." This was not shredded, but, coming from a 20-roller mill, was expected to be approximately as well disintegrated as No. 2. 4. Bagasse from Lahaina variety. Shredded in Searby shredder.

No particulars are given of the shredder, but a tabulated list of the various patents is included.

Methods of Making Chemical Pulp.

There are various well-known methods of making paper pulp.

(1) *The Sulphite or acid process,* of which there are two forms:—

(*a*) The *Quick or Ritter-Kelner* form, in which the digestion is carried out at a temperature of 150°C., using direct steam heating for ten hours at a pressure of 70 to 75 lbs.; and

(*b*) the *Slow or Mitscherlich* form, in which the temperature and pressure are much reduced, while cooking is carried on by externally-applied heat for a much longer period. The raw materials which are required to make the cooking liquor of bisulphite of lime for either form are sulphur and quicklime.

(2) The *Alkaline processes,* which make use of one of the following substances:—

(*a*) Milk of lime, (*b*) caustic soda, (*c*) sodium sulphate, of the various processes above mentioned, the soda (caustic) is usually employed with short-fibred wood, and sulphite and sulphate with long-fibred woods.

For cooking bagasse, either a vertical cylindrical digester or one of the rotary type may be used. Of the rotary digesters, the spherical has the advantage over the cylindrical, as it requires less floor space and is better designed to withstand high cooking pressures. The spherical is more difficult to load. The rotaries hold from 3 to 5 tons, whereas the vertical stationary holds about 20 tons. The conclusion is drawn that the spherical rotary type is the best for bagasse. Direct steam is used for heating. The ratio of cooking liquor to the weight of bone-dry fibre, or the liquor ratio, has an important bearing on the yield of pulp—3 : 1 was found to be satisfactory.

Results and Yield of Pulp Obtained.

The most suitable cooking liquor employed was 15 per cent. caustic soda, 7.5 per cent. soda sulphide.

The time and pressure of cooking are reciprocals—the longer the time, the lower the pressure, and *vice versâ.* The greater part of the experimental work was carried out at 100 lbs. pressure, and five hours cooking.

The amount of bleaching powder required to convert the brownish-grey unbleached pulp into a white bleached pulp varies considerably, being greatly influenced by the cooking conditions and by the extent to which pith has been removed. About 15 per cent. of bleaching powder will easily bleach all pulp. On a large scale this may be reduced to 12 per cent.

Hawaiian bagasse can be successfully reduced by either the soda or the sulphate process. The experimental difficulties as to yields and quality of pulp were found to be small. The sulphate process is slightly cheaper on account of the lower cost of chemicals, but it has the more objectionable fumes, and this may prevent its use in settled

districts, though, perhaps, it yields slightly more pulp, which is somewhat easier to bleach—30 per cent. of bleached pulp can be obtained, *i.e.*, 100 lbs. of air-dried original bagasse yields 30 lbs. of an undried bleached pulp. This was with the yellow Caledonian variety. "Hawaii 109" yielded 27 per cent., but Lahaina was much lower, yielding only 22 per cent. These percentages are higher if the yields are calculated on the dry shredded and sifted bagasse, *e.g.*, Yellow Caledonian then yields 48 per cent.

The process employed in cooking makes very little difference in the yield, as by the soda process the result was 30 per cent., and by the sulphate process 29 per cent.

Quality of the Pulp.

The three varieties yielded the same quality of pulp. The length of fibre is shorter than the typical bleached fibre of the soda process in the United States of America. Paper made from bagasse pulp is intermediate in quality between the United States of America soda and sulphite papers, and it would make an excellent book paper. For writing paper it imparts a certain "feel" and character to the sheet, which is very desirable. Although capable of yielding a good sheet of writing paper by itself, it would most probably be used with rag, sulphite, or soda fibre for the production of book paper and cheaper grade writing paper. In strength it is somewhat weaker than sulphite pulp, and is rather too weak for wrapping paper. One of the troublesome features is the fact that the bagasse is not available throughout the year. The crushing season lasts about eight or nine months. To operate a pulp mill economically it should be worked not less than 300 days a year, and therefore some provision would have to be made for the off season. The following methods are discussed in the Bulletin:—

1. Some other source of fibre might be employed, *e.g.*, bamboo has been found to yield an excellent pulp, which closely compares with bagasse.

2. Sufficient bagasse might be stored to supply the pulp mill when the sugar mill is not crushing. In this case it would have to be dried to prevent fermentation. It is suggested that a gradual surplus might be built up during the whole of the crushing season. The most serious objection to this process is the storage space required. The sifted bagasse necessary to run a 30-ton pulp mill for 100 days would occupy 1,200,000 cubic feet.

3. A pulp mill might be combined with a paper mill, and the former designed to produce, in the crushing season, sufficient pulp to keep the paper mill in operation for 300 days a year. Unlike the bagasse, the pulp need not be dried, as it can readily be stored in the wet condition, and the space required should present little difficulty. In the case of a 10-ton mill, approximately 1,000 tons of bleached pulp would have to be accumulated during the crushing season for running the paper mill for the balance of the year. The relative merits of making pulp and making paper have been carefully considered.

The remaining sections of the Bulletin cover the commercial aspect, and the figures are based on 1912 statistics, as conditions have been too

unstable since to make calculations that could have any permanent value. Furthermore, the local conditions must be taken into account. Entirely new figures would have to be compiled to make the financial side applicable to Australia. Some of the estimates, based on 1912 conditions, are as follows:—

Capital cost (1) for a 30-ton daily output for 300 days a year, (2) for a 10-ton daily output for 300 days a year.

	(1)		(2)
Pulp mill	£48,000	..	£32,000
Paper mill	42,000	..	
Power plant ..	20,000	..	10,000
Working capital ..	10,000	..	5,000
	£120,000	..	£47,000
Return on investment..	25%	..	15%

The plant to be installed would depend on the availability of capital, the supply of raw material, the market, and various other economic factors (labour, fuel, water, &c.).

Value of Bagasse as Fuel.

In the Hawaiian Islands we cannot consider bagasse as a by-product, as it has a distinct value, chiefly as a fuel. This value will vary according to the cost of the fuel which it replaces. On pre-war estimates this has been estimated at about 5s. a ton for green bagasse carrying 45 per cent. water.

The value of bagasse as a fuel depends on several factors, *e.g.*, the percentage of moisture and its thermal value, its cost and handling. Typical Hawaiian bagasse, with an average of 45 per cent. moisture, is calculated to have a heating value of 2,909 B.T.U. For Cuban bagasse, Meyers calculated the value as 3,848 B.T.U. on a 47 per cent. of moisture. Since bagasse commonly replaces some other fuel, its value is calculated on the efficiency with which it does so. In the figures quoted, Californian fuel oil is replaced, and from a knowledge of the boiler efficiency, calorific value, and costs of oil, the cost of wet bagasse is arrived at, equal to 1.2 dollars per ton.

Water Supply.

The question of water supply is important. In any locality the quantity of water required will depend on the character of the product. For high-grade rag writing paper as much as 150,000 to 200,000 gallons per ton are used, while for newspaper as little as 12,000 to 15,000 gallons per ton. In England, with esparto fibre, which is much like bagasse, from 25,000 to 50,000 gallons per ton are used. The conclusion arrived at is that 50,000 gallons per ton would be necessary, exclusive of water required for the steam plant. The purity of the water must not be overlooked, as is well known to paper-makers. The disposal of waste water containing much organic matter and the recovery of waste products must also receive careful consideration.

Market Conditions.

The market conditions of the Pacific Coast make it difficult to dispose of pulp on or near the coast, whereas there is little difficulty in disposing of paper. The cost of transporting pulp containing a high percentage of water points to the use of both a pulp mill and a paper mill as the best economic procedure. Hawaiian bagasse, on account of the low cost, ought to be more profitably converted into pulp than into paper since the latter operation is almost entirely mechanical, involving skilled labour, power, and supplies. The conclusion reached is that a well-designed 30-ton pulp mill and a corresponding paper mill would present an attractive commercial venture under normal conditions. Under the same conditions, a 10-ton pulp mill and a paper mill would not offer especially attractive financial possibilities. If the latter were designed so as to allow for large expansion, at least 100 per cent., the smaller plant might be an advantage at first, and might be converted into a better paying proposition at a later date. In any event, any decisive action should be deferred until trade and labour have reached more stable conditions.

The Cattle Tick.

By PROFESSOR T. HARVEY JOHNSTON, M.A., D.Sc.

There are several ticks which may infest cattle, but there is one which has such restricted host relationships that we term it *the* cattle tick (*Boophilus australis*). As a matter of fact, the parasite can infest horses and sheep as well, but not to the same extent as it does cattle. There is also another tick which is sometimes found on cattle, viz., the red-legged tick, *Rhipicephalus sanguineus*, but it infests certain other animals just as readily. Closely related forms to the *Boophilus australis* occur in the United States of America and elsewhere. They have essentially the similar life histories, and are capable of transmitting the same diseases of cattle.

The tick pest obtruded itself on public notice in Australia about 40 years ago by causing a high mortality amongst certain cattle in the Northern Territory. By degrees the tick invaded various parts of Queensland, causing at times very heavy losses. The spread was at first slow, but by 1895 it had reached the eastern coast. It was not till 1906 that the New South Wales border was crossed. The southern limit is at present in the Richmond River district.

The pest now occurs in practically all parts of Queensland where climatic conditions permit its establishment, *i.e.*, nearly half of the State, the Northern Rivers district of New South Wales, the Northern Territory, and the north-west of West Australia.

The life history may be briefly sketched. The engorged adult female tick, soon after dropping from the infested beast, lays about 1,500 to 2,000 eggs—occasionally a great many more. These eggs during warm and moist weather—especially during the late summer and autumn—hatch out as six-legged larvæ, which climb up any available object, whether it be animals, vegetation, fences, &c., though they do not wander very much laterally. Experimental work carried out in four localities in Queensland on behalf of the Commonwealth Institute of Science and Industry showed that the minimum period elapsing between the dropping of the tick and the earliest hatching out of larvæ from the eggs laid by it was seventeen days. The period was usually about 30 days in summer and 75 to 90 days during winter in the district between Wide Bay and the Tweed River, but in Toowoomba the summer period was about 36 to 60 days, while in winter the cold prevented any hatching at all. During hot, dry weather most of the eggs failed to hatch, and very few larvæ hatched out from the various experimental plots during winter.

The series of observations showed that if from cattle passing through a clean paddock in the coastal districts of south-eastern Queensland engorged cattle ticks were dropped, then such paddock would not become infective for other cattle for from three to four weeks in summer (November to March or April), and two to three months during winter.

The larvæ, or "seed ticks," which hatch out must gain access to a suitable host or they will die. They are, however, very tenacious of life, especially when they can obtain shelter from unfavorable weather. In our experimental plots they were not given an opportunity to infest an animal, and it was found that all the larvæ from any particular batch of eggs had died after a starvation of from four to six months during summer or winter. Thus, if cattle, horses, &c., be kept out of an infested paddock for six months, such paddock will probably become free from seed ticks, provided that larvæ be not introduced mechanically by water or by various birds and animals.

Should the larvæ reach a suitable host, they undergo a series of moults to become eight-legged nymphs and adults, the period between infestation and the dropping of the engorged (*i.e.*, egg-laden) female being generally about 21 to 24 days. Assuming that a female tick dropped from an ox on 1st October, and that the larvæ from the eggs laid gained access to cattle immediately on hatching, then between that date and 1st June following at least five generations would have made their appearance, and possibly many millions of ticks produced from that one tick. Of course, there are many checks against such enormous numbers developing to maturity—*e.g.*, activities of birds, effect of weather, failure to gain access to suitable host, failure of eggs to hatch, &c.

The influence of weather is very great. The effect on the hatching period and on the non-parasitic life of the larvæ has already been alluded to. In those districts of Queensland where heavy frosts occur the tick appears to have been, as yet, unable to establish itself. Cold winter nights, even if the temperature be not low enough for frosts, profoundly affect the egg and larvæ, death being a common result, while a retardation of the development of the larvæ within the egg will certainly occur should death not take place. Then, again, the female, after dropping from the beast, lives much longer on the ground during winter than in summer, and distributes her egg-laying in an irregular manner over a much greater length of time. Such eggs may be so retarded in their development that they (or a small percentage of them) hatch out in the succeeding spring and infest cattle. Under favorable conditions of warmth and moisture, practically all the eggs laid (90 to 98 per cent.) hatch out. Hot, dry weather has a very detrimental effect on the egg development; very few larvæ being produced under such conditions.

Diseases Produced in Australia.

There are two diseases, viz., tick fever, or redwater, and tick worry, or tick poverty, caused by tick infestation.

Tick fever, or *piroplasmosis*, is caused by a minute animal parasite called *Babesia* (or *Piroplasma*) *bigemina*, which is inoculated into the blood of cattle by the bite of an infected tick, especially in the larval stage. The organisms invade the red blood corpuscles, develop and reproduce at their expense, ultimately causing their destruction with resulting fever and liberation of blood pigment, which is eventually excreted by the kidneys. When this blood constituent—so important as the oxygen carrier of the blood, is voided in quantity, then the urine

may be markedly discoloured by the presence of the pigment in a more or less reduced form—hence the name *redwater*, which is sometimes given to the disease. Affected animals, if adult, commonly die, but young beasts pass through an attack with usually comparatively slight symptoms. A recovered animal is not, as a rule, subject to further serious attack, but it remains a potential source of infection, as some parasites persist in the blood, even for very many years. Apparently a true immunity is not established, but rather a chronic state of mild tick fever.

A necessary stage in the development of the parasite is passed through in the tick, the organisms which enter the ox blood, passing from the gut to invade various organs of the tick, some entering the ovary, and actually parasitizing the eggs. The larvæ which hatch from such infected eggs are infected, and it is they which are the chief means by which the disease is spread. Here, then, we have a case of so-called hereditary infection. It is not quite a correct term, since some eggs may not be infected, and thus from an infected parent some larvæ may be born infected and others not.

As most of the cattle country in Queensland is ticky, and since the beasts usually pass through an attack of tick fever while young, the mortality being slight, tick fever is not so dreaded now, except in case of new stock, *e.g.*, especially bulls brought in from "clean" country, such importations being usually "protectively inoculated" against *piroplasmosis*.

Tick worry, or tick poverty, is much more serious, and is due to the combined effect of the loss of blood abstracted by the hordes of parasites, the irritation set up by them, and the injection into the beast of some detrimental substance by the tick. Gross tick infestation, like tick fever, leads to interference with the condition of the beast, loss of milk in the case of cows, anæmia, and even death.

Effect on Commerce.

During the six years—1894 to 1900—it has been estimated that the mortality due to tick fever caused a direct loss of £3,500,000 sterling. To this must be added losses resulting from the diminution of natural increase. The losses due to tick fever and tick infestation at present are not nearly so heavy, but as they are occurring all over the cattle districts, they are certainly appreciable.

The loss in condition is a very serious item, as it results, not only in a reduced weight and quality of beef, but also in a diminution in the quality and quantity of milk produced by affected cows. Such interference with the milk supply re-acts on the dairy industry in its various activities, such as butter or cheese production, pig raising, &c. Another serious loss is experienced in regard to the value of hides. A committee of the Institute of Science and Industry, of which the writer was a member, after obtaining expert opinion, reported in 1916 that the depreciation of a ticky hide varied from 0½d. to 2½d. per lb. on the leather produced, and that the loss in Queensland in 1915 due to this cause alone was approximately £114,000.

We must add to the above items the costs for labour, material, and chemicals incurred in the building and maintenance of dips, the cost of Government inspection of cattle and dips, and the losses due to interference with stock movements.

Then, again, the lessening of production of any primary product, whether milk, meat, butter, bacon, &c., re-acts in reducing employment in the factories, wharfs, railways, business houses, machinery works, &c. There is no need to amplify, as these remarks are sufficient to show the interdependence of primary and secondary industries and city business.

Methods of Control.

These may be briefly indicated under the following headings:—

1. Those directed against tick fever in cattle;
2. Those directed against the tick during its parasitic stage;
3. Those directed against the tick in its non-parasitic stage;
4. Quarantine.

(1) The losses caused by tick fever, but not tick worry, may be minimized by inducing an attack of tick fever, commonly mild in character, by inoculating a small quantity of blood from a recovered beast, or "bleeder." The term "protective inoculation" is given to the procedure. It minimizes losses in stock, but does not control the tick in any way.

Certain drugs, *e.g.*, trypan blue, have been experimented with as injections into the blood stream, but their value as destroyers of the organism of bovine *piroplasmosis* has not yet been fully demonstrated.

(2) The chief measure adopted in the fight against the tick in Queensland is the application of a poisonous fluid, containing arsenic as its chief constituent. The fluid is generally applied in the form of a dip, but sometimes as a spray or wash. It is essential that every part of the surface of the animal be wetted with the compound, which must possess not less than a certain amount of arsenic in an active form. The mixture undergoes oxidation, which in this case means deterioration in value as a tick-destroying medicament. The exact strength needed apparently varies in different localities and under different conditions, and experiments have been undertaken with a view to determining it. Since the tick usually takes at least 21 days to reach maturity on the beast, dipping should be regularly carried out at intervals of not more than three weeks. The ox thus becomes a kind of tick trap, or tick collector, while the arsenical fluid is used as the destroyer.

(3) The chief measure to be adopted against the tick in its larval stage is starvation. By keeping horses and cattle away from an infected paddock for six months, practically all seed ticks become starved to death. Thus a systematic rotation of paddocks will enable a stock-owner to control tick infestation, and, if carried out in conjunction with regular dipping in a vat containing sufficient arsenic to kill ticks, will result practically in an elimination of the tick from his holdings. Bush fires destroy vast numbers of young ticks.

(4) If a property be tick free, then new animals should be kept in a separate small paddock, and systematically treated before liberation. State and Federal quarantine would assist in isolating ticky farms or tick-infested areas, and thus give the owner of a tick-free property an advantage in markets. More efficient control of straying stock, commonly ticky, on roads and stock routes is essential.

In addition to these methods, there ought to be a widespread educational campaign, so that individuals may become convinced that tick eradication is not only possible, but that it pays. There must be a strong central control, independent of political interference, local interests, and personal consideration. It must be invested with authority to enforce its will. Since the whole community suffers as a result of the presence of the tick, a fair proportion of the cost of administration should be borne by the general taxpayer.

Murray River Scheme.

Irrigation Development.

(By E. N. ROBINSON.)

Although the development of irrigation farming has been the subject of political discussion in Australia for very many years, it is only within a comparatively recent period that genuine efforts have been made to utilize our limited water resources for the promotion of primary production. Then when provision was made under various State schemes for irrigation settlement the response, for various reasons, was not encouraging. Now, however, the time has arrived when there is a clamorous demand for irrigation blocks, and the public Departments administering this branch of land settlement are being besieged by applicants for farms where water is provided. The pendulum has swung in the other direction, and irrigation is becoming the popular preference.

The River Murray conservation scheme is, therefore, attracting a wider and a deeper interest than it did when the agreement between the Governments of New South Wales, Victoria, and South Australia and the Commonwealth Government was ratified a few years ago. Out of this renewed and increased interest has arisen a good deal of misconception both as to the extent of new territory that can be made available for irrigation and as to the time in which the final work will be accomplished.

The former of these two problems is not of much importance to the present generation, for, judging by the rate of development of land settlement in the past, there must soon again be a sufficiency of irrigated land to meet prospective requirements. It is of the highest importance, however, in considering the ultimate economic development of Australia, and in assisting towards a realization of the narrow restrictions placed upon us by nature. From time to time various estimates have been made of the total area that can be brought into cultivation by utilizing the waters of the Murray and its tributaries, but these are continually being recast in conformity with new engineering proposals, and it is doubtful whether any engineer would indulge speculation except in the very broadest terms.

Under the agreement entered into between New South Wales, Victoria, and South Australia with the Commonwealth, a permanent Commission was appointed to carry out certain works and to make regulations for the utilizing of the waters of the Murray. The Commission consists of representatives of the Commonwealth and the three participating States, with the Hon. L. E. Groom as president. The main general scheme provides for the construction of a dam at Mitta Mitta, on the Upper Murray, which will enable the flow of the river to be regulated; and a supplementary storage at Lake Victoria. It embraces also the construction of twenty-six weirs and locks in the

course of the River Murray from its mouth to Echuca, a distance of 1,066 miles, and the construction of nine weirs and locks in the Murrumbidgee River from its junction with the River Murray to Hay.

The Commission will be the main controlling authority, although specific duties are allotted to the different States. For instance, the upper Murray storage, and the works between Echuca and Wentworth, will be constructed by the Governments of New South Wales and Victoria jointly and severally as may be mutually agreed upon by them. The works on the Murrumbidgee River will be constructed by the Government of New South Wales; the Lake Victoria storage, and the works on the River Murray below Wentworth, will be constructed by the Government of South Australia. The State Governments, however, must submit to the Commission for its approval designs and estimates of the work they propose to carry out, and the Commission's approval is necessary before the work may be put in hand. Power is given to the Commission to decide the order in which the work shall be undertaken, the rate of progress of works, and the method and extent of maintenance works. Certain other powers, such as the making of regulations, prescribing tolls, the times for deliveries of water, and the quantities of water to be delivered, comes within the jurisdiction of the Commission.

The upper Murray storage will contain 1,000,000 acre-feet of water. As the greater part of the land that will be submerged is of first class quality, many alternate schemes of conservation were considered, but it was found that there was no way out of the difficulty. Investigation soon made it clear that the cost of building a number of small dams to obtain a storage equivalent to that at Mitta Mitta would be prohibitive, owing to the configuration and formation of the country. The site selected was one of 28 that were examined, and occurs at a place just below the junction of the Mitta Mitta River and the Murray. When completed, this dam will throw back a body of water covering an area of over 47 square miles, which is more than double the area of Sydney Harbor, and will be by far the largest sheet of fresh water in Australia.

Of the 35 weirs and locks—26 of which are to be on the Murray between Echuca and Blanchtown, and 9 on the Murrumbidgee—one is already approaching completion. This lock is situated at Blanchtown, in South Australia, and the work was inaugurated by the State Government before the River Murray Waters Act came into operation. From Blanchtown to the sea, the river is navigable under natural conditions.

Another large construction work has also been taken in hand at Torrumbarry, a few miles west of Echuca, and arrangements are well in hand for the commencement of the construction of a weir at Renmark, and another near Cobdogla, a settlement nearer to the mouth of the Murray, in South Australia. The completion of the weir at Cobdogla will insure an adequate supply of water for many important irrigation settlements, some of which are now being prepared. The water will be dammed up and turned into Lake Bonney, which, when full, will have an average depth of about 12 feet, and an area of about 16 miles in one direction, and 3 or 4 miles in another.

The Torrumbarry weir will immediately serve an important purpose. At the present time, there are large areas in Victoria extending from

portion of the Goulburn Valley to Kerang, which is served by natural reservoirs known as the Kow Swamp and the Kerang Lakes. When the Torrumbarry weir is completed, the level of the river will be considerably raised, and these natural reservoirs will be able to be replenished when desired.

Another important work contemplated at an early date is the construction of a weir for the diversion, when necessary, of waters into Lake Victoria. Lake Victoria provides one of the finest natural storage basins along the whole length of the river. The object here will be, during times of plenty, to fill this basin, and then, as the river later recedes, to discharge its contents back into the river for the use of the settlements in South Australian territory. Lake Victoria is in New South Wales, about 4 miles inland from the banks of the Murray, and is 35 miles below the town of Wentworth, and 14 miles above the South Australian border. It embraces about 30,000 acres, and is connected with the main stream when the river is high by one or two creeks. It is estimated that when the natural intake and outlet have been improved, the capacity of the reservoir will amount to 514,000 acre-feet, which is just about half the capacity of the main storage reservoir at Mitta Mitta. When completed, the water, instead of being allowed to escape, whether it is required further down the Murray or not, will be regulated to suit the requirements of the irrigation settlements. It is expected that three years will be required for the completion of the work, and the estimated cost of £320,000 will be insignificant in comparison with the value of the results to be obtained.

That part of the scheme already authorized, together with the cost of land resumption, are estimated to cost £3,000,000; and since the Commission commenced its duties in 1917, a little more than £400,000 has been expended. The estimated expenditure for 1920 is £618,000, but it is doubtful whether this figure will be reached. Originally, the total cost of carrying out the complete works under the agreement was estimated at slightly more than £4,500,000, of which £1,000,000 was to be contributed by the Commonwealth, and the remainder to be provided in equal amounts by the three States. Since these estimates were prepared, however, there has been a very large increase in the cost of labour and material, and it is abundantly clear that the total cost will greatly exceed the first estimate. Obviously, it will be very many years before the scheme in contemplation will be completed.

The sites for some other weirs and locks have been decided upon, and others, from time to time, as the work progresses, will be undertaken. A commencement has been made with those which will give the greatest benefit, and which can be easily and more readily constructed.

Of recent years, several of the old-established settlements have been in a somewhat precarious position at various times, owing to the inadequacy of head storages, which has allowed the Murray to fall at various places too low for pumping requirements during the critical period of summer. At present, there are all the indications of a large expansion in the fruit-growing area along the Murray, and it is highly probable that the increased acreage which this huge conservation scheme will permit will be devoted mainly to the cultivation of vines

and citrus trees. The high degree of prosperity which the older-establishments have enjoyed during recent years is largely responsible for the keen demand now being made for land. But while all doubt has been removed as to the quality and quantity of the products of vineyards and orchards grown in this favoured territory, there is no certainty that the prices obtainable for dried fruits at the present time will be maintained indefinitely, or even for a long period. In anticipation of a greater and more reliable water supply direct from the Murray, enormous areas are being prepared by the Victorian and South Australian Governments for settlement; and, within the course of four or five years, the acreage under vines will possibly be doubled. This enormous increase must seriously affect the economic position of the industry and bring it into closer relationship with the competition of foreign countries. Such a possibility does not by any means argue the destruction of the industry, but it does call for a closer study of scientific problems affecting production, irrigation, and the transport of perishable products, so that Australia may utilize to the full the exceptional advantages which her combination of water, soil, and climate gives her over many of her rivals.

The engineering side of this important developmental project has received the most careful consideration; and, whatever the area may be that can be eventually watered, there is every reason to believe that it will be the full extent of the River Murray's capabilities. The maximum amount of water that can be conserved will be made available by the Commission for the development of industry; but there is now a further duty imposed upon Australia, viz., to see that the water is used to the best advantage, and that the products of the land are marketed to the best advantage. It has been the development of the science of irrigation which has made California the rich country she now is, and not merely the provision of water for the use of her settlers. The University of California and various State departmental institutions have solved many fundamental and vital problems in the interests of the producers. Very many millions of pounds have already been spent in water conservation in Australia, and many more millions remain to be expended. The full return from that outlay cannot be hoped for until Australia's own peculiar problems of irrigation cultivation have been studied. In co-operation with associations of irrigationists in New South Wales, South Australia, and Victoria, and with the Victorian Government, some experimental work has been initiated at Mildura, and while some of the problems that are being investigated are of general importance, others are of relatively local interest. If irrigation farming is to develop along sound and enduring lines, as in California, a comprehensive scheme of experimentation needs to accompany the conservation of the waters of the Murray.

The Corrosion of Condenser Tubes.*

Fifth Report of the Corrosion Committee of the Institute of Metals.

[The Institute of Science and Industry has recently been requested by large industrial organizations in Australia to investigate this problem in Australia.]

The present report is confined to the corrosion of condenser tubes —mainly 70 : 30 brass—and is a study of the practical problems of corrosion in condensers under service conditions, employing either sea water or fresh water. It is divided into four sections.

The first section deals with what has been called the diagnosis of condenser-tube corrosion. The procedure to be followed in withdrawing and preparing a tube for examination is described, also the symptoms or appearances within the tube which correspond to each of the five main types into which the practical problems of corrosion under fresh-water or sea-water conditions have been classified. The importance of additional information concerning (*a*) the water supply, and (*b*) the corroded tubes towards elucidating the cause of corrosion is shown and emphasized. This information, which is specified, has rarely been obtainable in the past, particularly as regards the water supply, and this may partly account for the lack of appreciation of the importance in corrosion troubles of the conditions existing within the plant. These conditions frequently vary very much from time to time, and it is shown that, although the conditions which favour accelerated corrosion may be present for but short periods at irregular intervals, and consequently may not be easily detected, the effect on the tubes may still be very serious. Also in certain cases it is shown that accelerated localized corrosion may persist after the initiating conditions have disappeared.

The second section is devoted to a consideration of certain features in the structure of condenser tubes, since an appreciation of these is of great value in following the mechanism of the types of corrosion studied later. Attention is principally directed to the presence on the tubes of a surface layer consisting of structureless and highly distorted metal. This layer has undoubtedly a greater resistance to corrosion by saline and fresh waters than the underlying crystalline metal, so that whenever this is penetrated corrosion will proceed at an increased rate. The layer has been stripped from a number of tubes of different composition. Its thickness is usually of the order of 0.01 mm., and indications have been obtained that its composition may be somewhat different from that of the underlying metal.

In the third section, the five main types of brass condenser tube corrosion are considered separately in detail.

Type I., General Thinning.—This type may be considered as an accelerated form of the complete corrosion which normally occurs in saline solutions, in so far as the tube is gradually and uniformly reduced in thickness. The rate of ordinary complete corrosion is too slow to be of any serious consequence in practice. Laboratory experiments with

* Official Summary of report read before the Institute of Metals, 11th March, 1920.

running sea water have shown that a period of fifteen to twenty years may elapse—even presuming that the rate of corrosion is uniform and does not decrease with time—before a tube is reduced 50 per cent. in thickness from this cause. Tubes almost always fail in practice by local action of some kind long before ordinary complete corrosion has seriously reduced the thickness of the tube. Rapid general thinning, however, is essentially a fresh-water phenomenon, and is usually associated with the presence of free acid in the water supply. The results of tests on ten samples of tubes of widely different composition in hydrochloric acid of concentration 3 parts in 100,000 at ordinary temperature show that in six weeks all tubes had lost from 2 to 4 per cent. in thickness. That such a very dilute acid should reduce the thickness of a tube so much in such a short time at ordinary temperature is ample evidence of the serious effect of acid in the water supply upon the life of condenser tubes. Proper neutralization, preferably at the source of contamination, is an effective remedy for this trouble, but considerable difficulty may be experienced in detecting the acid, especially if, as is generally the case, it enters the water supply only intermittently. Regular and frequent tests of the water must be made whenever this type of trouble occurs.

Type II., Deposit Attack.—The principal cause of pitting, which is the most frequent source of trouble in condensers, is ascribed to what is termed "deposit attack." In the presence of sodium chloride solutions, the cuprous oxide formed on a brass surface gradually changes to cuprous chloride. The latter is usually swept out of a condenser tube by the circulating water, but under various conditions may adhere at different parts of the tube surface. When such adherence has occurred, conditions now allow of the further gradual change of the insoluble cuprous chloride under the influence of oxygen to soluble cupric chloride and cuprous oxide. The action of cupric chloride solution on brass is very rapid, as may be gathered from the fact that a piece of brass tube, 2 inches long, placed in a strong cupric chloride solution at ordinary temperature, was completely disintegrated and partially replaced by a pseudomorph in copper in two days. The action involves the oxidation of the copper and reduction of cupric chloride to cuprous chloride. Redeposition of copper from solution by the zinc also occurs. In the presence of air cuprous chloride will again be converted to cupric chloride and the attack on the brass continued. Thus the action is both recurrent and local. Foreign bodies, and particularly colloidal bodies, lying in the tube have an injurious effect by serving as loci for the adhesion of cuprous chloride and by preventing the diffusion of cupric chloride. Observations on the incidence and distribution of pits in condenser tubes are shown to agree with the results which would be expected to follow from the above explanation of the mechanism of pitting. Attention is drawn to the importance of keeping tubes clean and as free as possible from foreign bodies as a means of preventing deposit attack.

Type III., Layer Dezincification.—An account is given, preliminary to the consideration of this type of corrosion, of the mechanism of so-called dezincification. The conclusion is reached that true parting of zinc and copper in a 70 : 30 brass does not occur, but that the

so-called residual copper is always redeposited copper. Dezincification is therefore only apparent and not real, and the term is always subsequently employed by the authors in this sense.

The layer type of dezincification, which is characterized by disintegration of the brass tube and redeposition of copper over large areas, has been found to occur under both marine and fresh water conditions. Several ways in which such action may occur are indicated. Under fresh water conditions, it is often associated with acid water, particularly if the acid is not too dilute and the access of oxygen is not very easy.

Type IV., Plug or Local Dezincification.—This type of local corrosion may be regarded as a form of deposit attack, as it always proceeds beneath a deposit, and is stimulated by the presence of foreign bodies. It differs, however, in many ways from Type II. So far as is known, it occurs only in sea water—or diluted sea water—and is always associated with adhering white salt, consisting of colloidal zinc oxychloride, also containing some carbonate. It is readily reproducible in the laboratory, as it occurs spontaneously on the surface of 70 : 30 brass tubes after immersion in sea water at elevated temperatures—40 deg. to 50 deg. cent. —for a few days; and is hence rather more amenable to experimental study than the previous types of corrosion. It is shown that the production of the right concentration of zinc in the liquid layer adjacent to the corroding brass surface plays a large part in the formation of the characteristic white oxysalt, and that interference with the production of this condition, *e.g.*, by lowering the zinc contact of the brass or by raising the zinc content of the sea water, is sufficient to prevent its occurrence. The dezincifying action is thought to be due to a small concentration of hydrochloric acid contained within the colloidal white salt. The difference in behaviour of different batches of 70 : 30 tube—some always showing local dezincification, others never—persists after annealing or pickling, or both, and the reason for the difference in behaviour is still not clear.

Type V., Water-line Attack.—In the case of a brass tube only partially immersed in sea water, increased corrosion—compared to that of the immersed portion—takes place, not at the water line as is commonly supposed, but above it, and sometimes as much as 2 cm. above the air-sea-water surface. Further, the attack is not uniform, but is concentrated at areas where salt deposits have formed and is coterminous with the area covered by the deposits. Narrow bands of salt connect the sea water with the deposits. This type of corrosion is obviously a special form of deposit attack, taking place under the most favorable conditions, inasmuch as the attack beneath the deposits is much more severe than in any of the previous types of corrosion. This type of attack may occur at the inlet end of condenser tubes when entangled air clings to the surface of the tube and is prevented by eddying effects from being swept away by the water flow.

The fourth section of the report contains an account of preliminary work on the electrolytic protection of condenser tubes. The particular question investigated was that of the efficiency of electrolytic protection in preventing deposit attack, *i.e.*, attack by cupric chloride solution. A piece of 70 : 30 brass tube made cathode to strip iron in a normal

cupric chloride solution is very distinctly attacked despite the small current passing from the solution to the brass. It is considered that an electric current slows down, but does not necessarily inhibit corrosion of a cathode. By raising the current density sufficiently it is possible that all corrosion, even in a cupric chloride solution, may be prevented. Experiments have shown, however, that a current as large as 20 to 25 amperes per 1,000 square feet is insufficient to prevent a 70 : 30 brass tube from being rapidly corroded by such a dilute solution of cupric chloride as a one-twenty-fifth normal solution. Some suggestions are made whereby the usefulness of the electrolytic protection process may be extended by special manipulation of it in the early part of the life of a tube, with the object of forming a thin continuous layer of calcium carbonate over the surface of the tube.

Progress in the Dehydration Industry.

By C. E. MANGELS, Washington, D.C.*

The preservation of fruits and vegetables by dehydration has been given much prominence during the past three years. Dried fruits have been staple articles of food for a number of years, but the dehydration of vegetables presented many problems not met in the drying of fruits. Fresh vegetables wilt or spoil much more quickly as a rule than fruits. The slow processes used for fruits have not, therefore, been applicable to vegetables.

Dehydration of fruits and vegetables has been, and still is, a very fertile field for investigation. Dehydration became still more important to us when the United States entered the war, and the necessity for vegetable food in the concentrated form became apparent. The United States Department of Agriculture, particularly the Bureau of Chemistry, has conducted extensive investigations on the preservation of fruits and vegetables by dehydration. These investigations have had a very wide range, and the problem has been attacked from many different angles.

When the United States entered the war in 1917, a vegetable dehydration industry already existed in Canada. The plants in Canada dehydrated vegetables for the allied armies, the principal products being dried sliced potatoes, and the Julienne soup mixture. A few plants engaged in the dehydration of vegetables existed in this country before the war, and the declaration of war by the United States gave impetus to the enlargement of existing plants and the formation of new organizations. Unfortunately, there was also created a very fertile field for stock-selling schemes and exploitation of worthless patents.

When the armistice was signed in November, 1918, a number of plants were engaged in the dehydration of vegetables. Practically all of these plants were engaged solely in the filling of Army contracts, and had not even attempted to develop any other outlet for their products. Consequently, when all outstanding contracts were cancelled by the Army in February, 1919, the whole industry was placed in a very precarious condition. The outlook for dehydration was unquestionably discouraging, but many of the manufacturers immediately made plans for the development of other outlets for their products, and planned primarily to develop a domestic market. The success of their efforts has been encouraging. Not only have many of the existing plants continued to operate, but new organizations have been formed, and new plants erected during the past year. Dehydration has not been merely a war visitor, it has come to stay.

The products produced for Army use were not unwholesome, but their quality was not such as would tend to create a strong domestic

* Investigator, Division of Dehydration, United States Department of Agriculture. Paper presented at annual meeting of the American Society of Heating and Ventilating Engineers, New York, N.Y. January, 1920.

demand. The first step, therefore, in creating a domestic market for dehydrated products was the improvement of the products. While perfection has by no means been reached, the improvement in quality during the past year has been remarkable.

How has this improvement in quality been accomplished? It has not been accomplished by any extensive changes in the drying equipment of these plants. Excellent drying equipment, we find, does not necessarily produce excellent dehydrated products. The products produced this season have, as a rule, been more palatable, have had a more appetizing appearance, and have better keeping qualities. While many manufacturers have in the past been able to produce palatable dehydrated vegetables of good appearance, the products generally would not hold up in storage at ordinary temperatures, even in sealed tins.

Two types of spoilage have been common in dehydrated vegetables. The hardest type to control is the infestation by moths and other insects. The other type of spoilage is due to chemical changes which are not associated with bacteria and moulds, but are probably due to the action of oxidases or enzymes. The Division of Dehydration has conducted investigations as to the action of moulds and bacteria on dehydrated products. All of the data secured to date indicate that dehydrated products will not be subject to spoilage through the action of moulds and bacteria when stored under reasonable conditions. Moulds appear to require a moisture content of at least 24 per cent. for their development, and the average moisture content of dehydrated vegetables is well under 15 per cent. Bacteria in dehydrated vegetables decrease in number in storage.

This deterioration in dehydrated vegetables, due to chemical changes, is manifested differently in different vegetables. In the case of cabbages and onions, the dried product becomes brown in colour and loses its characteristic flavour. In the case of carrots, the red colour disappears, at times associated with the darkening of colour and loss of flavour. Our observations indicate that in most cases these changes are due to the action of enzymes or oxidases. Neither the type of dryer nor the system of drying appears to be a factor. Several factors tend to control these changes, which further lead us to believe they are due to the action of enzymes or oxidases.

Investigations have shown that the moisture content of the product is a factor which controls the rate at which these destructive changes take place—the lower the moisture content the slower the rate of deterioration. At ordinary room temperatures, vegetable products, with a moisture content above 1 per cent., deteriorate quite rapidly—in four to six weeks—while the same products, with moisture contents of 3 to 5 per cent., show no changes until after four to six months of storage. Improvement of the keeping qualities by drying to a very low moisture content is not commercially practicable, however, for two reasons: First, the removal of this extra moisture means a longer drying period, a higher cost of drying, and especially a greater danger of scorching; second, after drying the product to this low moisture content, it is necessary to pack it in moisture-proof containers in order to avoid absorption of moisture from the atmosphere. The average commercial moisture content of dehydrated vegetables is approximately 10 per cent.

It is also true that samples of dehydrated vegetables, with a moisture content of approximately 10 per cent., showed no deterioration when stored in a refrigerator at a temperature varying from 32 to 40 degrees Fahr.; while the same samples would show a very marked deterioration when stored a like period of time at a room temperature of 70 to 80 degrees Fahr. The cost of refrigeration makes this method impracticable.

This deterioration, as previously stated, is not associated with bacteria for moulds, but may be attributed to the action of oxidases or enzymes. The destruction of these enzymes should, therefore, prevent this deterioration. Enzymes are as a class easily destroyed by heat, and, therefore, by blanching or slightly pre-cooking the vegetable before dehydration, the enzymes present are destroyed. This is accomplished by dipping the vegetables in boiling water or steaming a short length of time before drying. This treatment has proved very effective in preventing this type of deterioration, and is now in use by practically all of the dehydration plants. Blanching or processing with steam or hot water is an art rather than a science. As manufacturers master this art, the products will improve in quality. Several factors will always influence the method and the time used, for instance, the product, the manner in which it is cut or sliced, and in some cases the variety and state of maturity. Insects, particularly moths, were a serious menace to the dehydration industry last year. The moth commonly found in infested products is known as the "Indian meal moth." In co-operation with the Bureau of Entomology, United States Department of Agriculture, we have outlined apparently successful methods of control. The usual practice in dehydration plants had been to store the dehydrated products in open bins previous to packing. This practice offered an excellent opportunity for the adult moth to deposit eggs on the dehydrated products, which eggs developed into larvæ after packing. By packing immediately after dehydration in moth-free rooms, or storing in moth-tight bins, the deposit of eggs is practically eliminated. Infestation may occur later, however; when dehydrated products are stored in ordinary cartons, the larvæ of the moth may gain access to the material through the crevices of the package. Packing in a moth-proof carton would, therefore, be highly desirable, although the principal point of infestation is before packing.

The keeping qualities of dehydrated vegetables have been greatly improved by controlling these two types of spoilage. Improved operating conditions and attention to details have largely eliminated the scorched, overdried, unpalatable product of the past. One practice—the use of sulphur dioxide fumes—has been practically eliminated in vegetable drying. The reason is simple. The sulphurous acid obscured and destroyed the delicate flavour of the vegetables.

During the war, dehydration plants were principally concerned with the dehydration of vegetables. Since the war, however, when located in a fruit-producing region, these plants have given much attention to the dehydration of fruits. This is particularly true on the Pacific coast. Dehydration plants have been able to produce products decidedly superior in quality to the ordinary sun-dried or evaporated fruit. These "dehydrated" fruits (as the producers choose to call them) have a

flavour very closely approximating that of the fresh fruit, and when placed in water more nearly resume the texture of fresh fruit. The products of dehydration plants are sulphured much less, and contain, on an average, 5 per cent. less water than the ordinary dried or evaporated fruit.

A rather higher moisture content has always been permissible in fruits, due to the high acid and sugar contents, which tend to act as preservatives. In the ordinary dried or evaporated fruits, the moisture content is often high enough to be favorable to the development of moulds. The moisture content of the "dehydrated" fruit is generally under 20 per cent.

Sulphuring of fruits has long been practised on the Pacific coast. Sulphur dioxide fumes are used to bleach the fruit before drying, and the retained sulphurous acid acts as a preservative after drying. Sulphuring, no doubt, facilitates handling of the fruit, but heavy sulphuring is very objectionable. The sulphurous acid obscures and destroys the delicate fruit flavour, and in heavily sulphured products we have left only a tart or sweet taste.

The dehydration plants use sulphur dioxide as a bleaching agent only, and not as a preservative. The products are sulphured very lightly, and the sulphurous acid is removed from the products in the process of drying. The fruit is generally given a short steaming before drying, and this steaming, together with the lower moisture content, assures a product of good keeping qualities.

There has been little or no change during the past year in the drying equipment of existing plants. Two attempts were made to use a moving belt dryer for dehydration of fruits and vegetables. One attempt was wholly unsuccessful, and the other only partially successful. A plant must be able to handle a variety of products—both fruit and vegetables—in order to prolong the operating season, and thus cut down the overhead expense. A dryer, using trays, is essential for some products, notably the softer fruits, and therefore any type of dryer in which trays are eliminated will have a very limited use. In one essential, all of the dehydration equipment is similar—air is used as a medium for conveying heat to the product and carrying away the evaporated moisture. In the simplest type, atmospheric air is heated to the desired temperature, passed over the product, and discharged. In other types, the relative humidity of the air is raised (in some cases as high as 60 per cent.) by re-circulating the air. The majority of dryers may be classed as tunnel dryers, and many other drying units are essentially modifications of the tunnel type. The kiln type is, of course, an exception.

Vacuum dryers have been used in various industries for some years, and are at present used for the drying of milk. Vacuum has long been a laboratory aid to the chemist in drying food materials. While fruit and vegetables of good quality can be produced in a vacuum dryer, their quality is not superior to those dried in a current of air. Further, the most expensive type of dryer using air as a medium of evaporation is much less expensive per unit than vacuum dryers.

While there has been very little change in the type of equipment during this past year, it does not mean we have reached perfection in equipment. There is yet much room for improvement in drying equipment, but if any one expects to see existing plants dismantle and replace their equipment, he is certain to be disappointed. The equipment will be improved by minor changes in the existing equipment. We wish especially to caution inquirers that dehydration of fruits and vegetables presents problems quite different from the drying of textiles, soaps, &c. Unfortunately, many designers of plants ignore the fact that they are dealing with a product which has a cell structure, and that the water must be removed from these cells without injury to the cells.

An industry very closely related to dehydration has developed in the past two years—the potato flour industry. Mills are now operating in at least five States. The process used may be briefly described as the "hot roller or drum process." The cooked, mashed potato is spread in a thin layer on a large steam-heating revolving drum, dried, and scraped off in "flakes." The "flakes" are then ground into flour. This process is sanitary, and largely eliminates labour costs. While the process was developed in Europe, the American manufacturer has greatly improved the product.

It will probably be possible to prepare other vegetable flours by this process, but it cannot be applied to all vegetables. The Division of Dehydration made an unsuccessful attempt to use this process for manufacture of sweet potato flour. The sweet potato flour produced was very hygroscopic, and caked in storage. Any vegetable that tends to become sticky or gelatinous when cooked can hardly be used by this process, since the material must be cooked soft before it can be handled.

In closing, I wish to sum up, in a measure, the needs of the industry to-day. We need more investigations, especially on the technique of preparation. Products have improved this year, but perfection has not been reached. Moreover, there is still a lack of uniformity in quality.

A domestic market must, and will, be developed for dehydrated products. This does not seem out of reach now. The individual manufacturer who is now endeavouring to establish "his brand" is indeed wise. The public will soon be calling for standard brands of dehydrated foods.

A dehydration plant must essentially have a good business organization behind it. It will be the difference between success and failure. The raw materials must be secured at a reasonable price, they must be handled properly, dehydrated properly, and packed properly. A careless, slipshod organization cannot do this.

The manufacturer who sits in his office and waits for some one to order his products is lost. He must go after business. Our observations have convinced us that aggressive salesmanship can dispose not only of high-grade products, but actually sell inferior goods. It always takes a real salesman to introduce new wares to the public.

Energy from the Sun.*

Physicists tell us that if we disregard atmospheric absorption, the sun delivers energy to the earth at the rate of 7,000 horse-power per acre; but though the fact cannot be disputed in the face of the concordant data as to the solar constant now available, very little has yet been accomplished in solving the problem of utilizing this energy in the form of mechanical work. Since the temperature of the sun is about 6,000 deg. Cent. (absolute), Carnot's theorem shows us that of the energy received here, a proportion equal to about $\frac{6{,}000 \text{ deg.} - 300 \text{ deg.}}{6{,}000}$ or over 95 per cent., should be convertible into work, at least from the theoretical stand-point.

The only methods by which it has yet been attempted to convert the solar energy into mechanical work have, however, involved a degradation of the energy received from its high-grade condition as radiation into low-temperature heat. The immediate consequence is that the energy, even theoretically, convertible into mechanical work falls from 95 per cent. of 7,000 horse-power per acre down to, say, 25 per cent. of 7,000 horse-power, or 1,750 horse-power per acre. This is, of course, merely a theoretical result, and is very far from realizable in practice. Indeed, in certain regions, the atmosphere exacts a toll of nearly 50 per cent. on the energy it transmits, but as this defect of transparency is closely associated with the amount of aqueous vapour in the air, the loss is very substantially less in arid areas. As indicating what fraction of this power is actually attainable with present appliances, the figures given in a paper read on Monday last before the Society of Engineers by Mr. A. S. E. Ackermann, B.Sc., have much interest, although they lead to the negative conclusion that there is little prospect of commercial success being achieved along these lines.

The site of one of the installations tested by Mr. Ackermann was at Meadi, Egypt, and the trials extended over about three weeks. The area occupied by the sunshine-absorbing plant was seven-eighths of an acre, and the highest output recorded was 19.1 pump horse-power, as against the 5,000 to 6,000 horse-power which would have been obtained from a perfect motor capable of utilizing the radiation direct. Somewhat better results were obtained in some previous trials near Philadelphia, where tests made by Mr. Ackermann, extending over a period of five hours, were, he claimed, equivalent to the development of an average of 18.54 horse-power from a sunshine-absorber occupying an area of 0.41 acre. The maximum rate of power development during this test was 26.8 brake horse-power, and the lowest 8.6 brake horse-power.

These figures bring out well the characteristic difficulties attaching to any attempt to retrieve mechanical energy from the sunshine by converting the latter into heat. These drawbacks are the enormous area

* Extract from *Engineering*.

occupied and the costly cumbrousness of the plant, to which must be added the great variability in the rates of power production. In short, the system seems to present in an exaggerated form all the drawbacks attaching to wind-power.

Ruskin, in one of those works which are at once a delight to the lover of literature and the despair of the seeker for ideas, reproved his generation for preferring steam-power to air-power since the latter, he observed, cost nothing. Such fallacies constitute, of course, much of the stock-in-trade of all superficial writers, but commonly find a happy oblivion in the corner of a country newspaper or in the pages of a popular magazine. They do no harm save when as in Ruskin's case the sterility of the "half-idea" is to some degree concealed by the perfection of the phraseology in which it is embodied. It was his contemporary who pronounced the bulk of his generation to be "mostly fools," and, though Ruskin was less direct in his methods, he evidently thought that the preference for steam of the great creative intellects of the past century was to be attributed to innate imbecility or sheer perversity. His suggestion, however, merely illustrated once more the every-day fact that the man who writes easily will not often be bothered to cull the results of the past experience of mankind, but, like the proverbial German anatomist, prefers the, to him, easier task of constructing his "camel" out of his inner consciousness.

Wind-power is, of course, cheap only in exceptional circumstances, where the total amount of power required is insignificant, and intermittency of working is immaterial. A windmill 40 feet in diameter is rated at about 8 horse-power, and costs about £400, or about £50 per horse-power. It cannot be relied on to work for more than one-third the total number of hours in the year, and, even so, the working hours are distributed erratically.

In this latter regard a sun-power plant would, in a favorable climate, probably be somewhat less capricious, but the windmill, cumbrous and bulky though it may be in comparison with its effective output, is still many degrees superior in this regard to the best sun-power plant yet constructed.

In the plant erected at Meadi, and described in Mr. Ackermann's paper, the steam-generators comprised a series of elements, each consisting of a cast iron boiler 3½ inches wide by 14¾ inches deep and 205 feet long. This boiler was arranged at the centre of a parabolic mirror of the length stated, and measuring rather over 14 feet in extreme width. Of these huge mirrors there were five, and the reflecting portion consisted of flat plates of silvered glass arranged round a parabolic surface. These enormous mirrors were mounted on rollers, as it was necessary to make them "follow the sun" in its passage across the sky from east to west. The plant was found to work best with a steam pressure of about 6½ lb. gauge. The engine was of a very special design, having small clearances and very large exhaust ports, the latter being provided in order to take better advantage of high vacua than is practicable with the normal type of reciprocating engine. In some preliminary trials, some excellent results have been recorded with engines of this type, an efficiency ratio of as much as 52.7 per cent. being obtained, which is certainly a remarkable figure for an engine

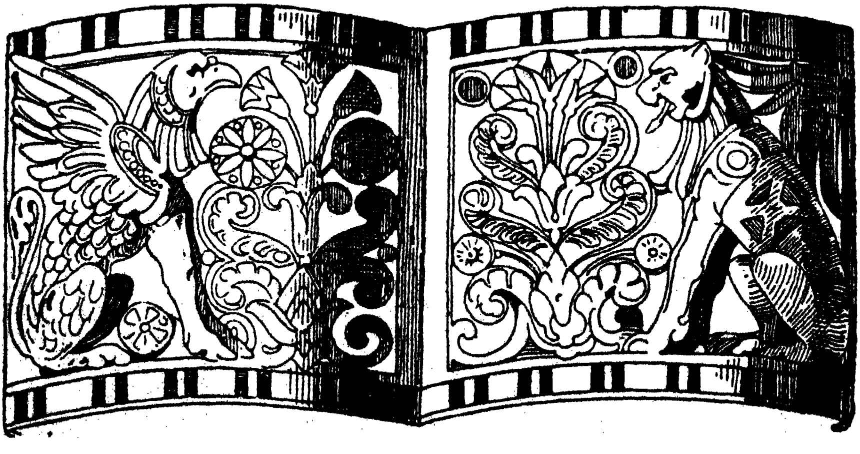
developing only 29.6 horse-power, with steam supplied at 15.8 absolute, and with a vacuum in the condenser of 28.07 in. For a small output such as this, the reciprocating engine is no doubt superior to a steam turbine; but were it commercially practicable to construct a large sun-power plant, it would obviously be desirable to substitute a steam turbine, with which a materially higher efficiency ratio would then be readily realized.

At the Meadi tests, it appears that the engine did not work satisfactorily, so that the steam consumption was exceedingly high; but, even assuming that as good results are obtainable as with a large exhaust steam, the output in brake horse-power would still, on the Meadi figures, not amount to an average of 70 brake horse-power per acre, so that even a 1,000-kw. plant would require a gathering ground of nearly 14 acres. It would probably not be possible to generate at the above rate for more than 3,000 hours per year, even under very favorable climatic conditions, and the unwieldy character of the plant is thus sufficiently obvious.

The output would, no doubt, be raised were the steam pressure increased to 200 lbs. per square inch; but in the exposed position in which a sun boiler must needs be placed, it is quite possible that the increased convection losses would go far to offset any particular gain in this direction. If, however, the apparatus could be sheltered from wind, very high temperatures could, no doubt, be attained, but there would be obvious difficulties in utilizing them. Since the temperature of the solar radiation is that of the source, there is no physical bar to the attainment of extremely high temperatures, with a corresponding gain in the Carnot efficiency. In short, theory shows that a body exposed to the solar radiation, prevented from losing heat to the surrounding space, would attain the temperature of the sun, even without any concentration of the rays of the latter, and it would be of considerable interest to determine the temperature thus attainable inside a well-silvered vacuum flask. In practice with high temperatures, however, the gap between the Carnot efficiency and that actually attainable rapidly widens. Gas-engine makers discovered this long ago, the loss of heat to the cylinder walls increasing more rapidly at high temperatures than does the gain from the greater availability of the heat energy. Inside a gas engine cylinder temperatures of 2,000 deg. Cent. can be dealt with fairly successfully; but, whilst there should be no serious difficulty in attaining a temperature of this order from concentrated sunlight, there are no obvious means to hand by which energy supplied at this temperature could be successfully converted into work. If the solar engine is to be a heat engine, it would seem that it must be a low-temperature engine, and this, of course, involves an enormous waste of availability, and this waste will, in practice, be notably more than indicated by the theory. Bad as the solar-heat engine is, it is, however, probably at least equal to Nature's own method of converting sunlight into a form permitting of its utilization for the production of mechanical work. A few tons (largely water) per acre is the net result of many months' conversion of radiation into chemical energy, and the 1,000,000,000 tons of coal now produced annually is the product of milleniums of sunshine over vast areas. The energy thus stored

for us can, moreover, only be converted into mechanical work at a vast sacrifice, which future improvements can but little diminish. Even in the Diesel engine, not more than some 33 per cent. of the energy of the fuel is realized as brake horse-power at the crank shaft, about two-thirds of the total supply being thus lost to the exhaust.

No doubt posterity, if civilization is to be maintained at the level to which the engineer has raised it, must find some substitute for our rapidly diminishing coal supplies, and many considerations point to sunshine being the principal source of power in ages yet distant; but it seems highly improbable that the conversion of radiation into mechanical work will be effected by the essentially crude device of first degrading the energy into heat. Theoretically, of course, a direct and efficient conversion of radiation into work is possible, but as the only mechanism yet conceived to this end involves the construction of a kind of turbine with a bucket speed comparable to that of light, or the production of absolutely perfect reflectors, this theoretical possibility advances matters little or nothing; and we must hope that some indirect method may yet be discovered which will avoid the drawbacks inherent in such schemes as have already been tried, whilst equally evading the insuperable obstacles in the path of a direct attack.



Flies as Transmitters of Certain Worm Parasites of Horses.

By T. HARVEY JOHNSTON, M.A., D.Sc., Professor of Biology, University, Brisbane.

It is well known that flies play a very important part in public health matters, as they can so readily act as passive carriers of various bacteria which cause human disease. It has recently been proved that house flies act as intermediate hosts for several of the species of tapeworms which infest poultry.

As long ago as 1861, it was pointed out by Carter that in Bombay, India, house flies were commonly infested with a tiny nematode parasite, which was found in the proboscis. He named it *Filaria muscæ*. It was not until 1911 that its life history was known, Dr. H. B. Ransom, of the United States Bureau of Animal Industry, proving that the worm was a larval stage of one of three species of *Habronema* parasitizing the stomach of horses. In 1912, the author recorded the occurrence of this worm in certain flies in Australia, viz., the house fly (*Musca domestica*), the stable fly (*Stomoxys calcitrans*), and the common "cattle fly" or "bush fly" (*Musca vetustissima*, incorrectly called *M. corvina*). That reported from the stable fly is now known to be the larval stage of a related parasite of the horse, viz., *Habronema microstoma*.

In 1916, Dr. Bull, of Adelaide, drew attention to the presence of *Habronema* larvæ in granulomatous sores in horses in Victoria and South Australia. He believed that "swamp cancer" of equines in the Northern Territory was also due primarily to infection by these tiny worms.

In 1918, Drs. Lewis and Seddon mentioned the common occurrence in Victorian horses of an inflammatory condition of the eyes, caused by larval *Habronema* worms. At the end of that year, Mr. G. F. Hill published a very important paper, in which he described the life history of all three species which infest the horse, *H. muscæ* and *H. megastoma* (the latter causing worm tumours in the stomach), utilizing the common house fly (*Musca domestica*) as their intermediate host, while *H. microstoma* passed through its larval stages in the stable fly (*Stomoxys calcitrans*). Last year Dr. Bull confirmed Hill's observations, and extended our knowledge of the granulomatous condition of horses caused by such larvæ.

Late in 1918 work was begun at Eidsvold, Burnett River, by Miss M. J. Bancroft and the author, with a view to determining whether all or any of the three parasites could complete their larval cycle in various Queensland flies, more especially those which are commonly associated with horses and cattle. The results have been published in a paper entitled "The Life History of *Habronema* in relation to *Musca domestica* and Native Flies in Queensland" (Proc. Royal Society, Queensland, 1920).

The larvæ of various flies which breed in horse manure were allowed to feed in samples of this material contaminated with the eggs or larvæ of two or more of the species of *Habronema*, the adults which emerged

(also some of the pupæ) being carefully examined for the presence of worm larvæ in later stages of development. In addition, captured flies were dissected and results noted.

Worms were found in various situations, being present in the abdomen, thorax, and head, and when sufficiently developed to escape from infected flies, they were to be found in the proboscis.

The following species of *Musca* were used in our work: *M. domestica* (the house fly); *M. fergusoni*, Jnstn. and Bancr.; *M. vetustissima*, Walker; *M. terræreginæ*, Jnstn. and Bancr.; *M. hilli*, Jnstn. and Bancr.; all but the first-named being "bush flies" or "cattle flies." We also utilized the stable fly (*Stomoxys calcitrans*), flesh flies (*Sarcophaga misera*, Walker), certain metallic flies (*Pseudopyrellia* sp.), and the common blowfly (*Anastellorhina augur*). All species were found, either naturally or under experimental conditions, to be able to harbor larvæ of one or more of the species of *Habronema*, acting in the capacity of intermediate hosts, and not merely as mechanical carriers of the parasites.

Stomoxys was found to be capable of harboring only *H. microstoma;* while the five species of *Musca*, together with *Sarcophaga* and *Pseudopyrellia* were suitable intermediate hosts for both *H. muscæ* and *H. megastoma*, but not for *H. microstoma*.

The blowflies became parasitized by transferring the young larvæ from meat to infected horsedung, 7 per cent. of the emerging flies being found to harbor immature *Habronema* worms, but to which species they belonged could not be satisfactorily determined. It was not ascertained whether these nematodes could complete their larval development in the blowfly. Since blowflies do not normally breed in horse manure, they are of little importance as transmitters of the worms under notice.

H. muscæ was found to be much more common than *H. megastoma* in flies. Sometimes both species occurred in the same insect.

The following table gives a summary of our results with flies in which statistical record was kept:—

CAPTURED FLIES.

Species.	No. Examined.	*No. Infected with *Habronema* spp.	Percentage Infected.
Musca domestica	122	10	7·6
M. fergusoni	1,176	26	2·2
M. vetustissima	280	14	5·0
M. terræreginæ	21	1	4·8
BRED FLIES.			
M. domestica	165	98	59*
M. fergusoni	58	55	95
M. vetustissima	60	60	100
M. terræreginæ	10	10	100
M. hilli	12	10	8·3
Pseudopyrellia sp.	6	6	100
Sarcophaga misera	25	11	44
Anastellorhina augur	28	2	7·1

Hill's record for infected house flies was also 7.6 (14 parasitized out of 182 examined in Melbourne), all with *H. muscæ* alone. Ransom found 28 per cent. infected (39 out of 137) in certain United States

* Omitting one experiment in which the horsedung was almost certainly not infected, the figures were respectively 115 examined, 98 infected, percentage 82.

localities. The percentage infection of house flies captured in stables by us was 7.6. Under experimental conditions, using horsedung known to be infected, 82 per cent. of the emerging flies harbored *Habronema*, the number of parasites in each infected fly varying from 1 to 41. In addition to these Eidsvold records, we found that 27 out of 66 *M. domestica* bred from horsedung from a livery stable in Brisbane were infected (*i.e.*, 41 per cent.)—23 with *H. muscæ* alone, 3 with *H. megastoma* only, and 1 with both species.

The low percentage (2.2) of infection amongst captured *M. fergusoni* was almost certainly due mainly to the fact that this fly prefers cowdung to horsedung for larviposition, hence few larvæ were likely to become infected with *Habronema*. On the other hand, when the species was bred from horse manure, it became readily infected (95 per cent.). The number of worms found in parasitized captured flies ranged from 1 to 18, with an average of 4; whereas in bred infected insects the number varied from 18 to 91, being frequently between 40 and 70. As already stated, this species breeds normally in cowdung in preference to horsedung; so also does *M. vetustissima*, which gave similar results in regard to infection, being 5 per cent. in captured flies, and 100 per cent. in bred flies. In the latter case, infestation was often extremely heavy, in one batch of 22 the numbers ranging from 39 to 97, with an average of 71 worms, both species being represented. In regard to *M. terræreginæ* and *M. hilli*, both were very scarce in the district, but when bred out from infected horsedung in Eidsvold and Brisbane respectively, both became readily infected with both parasites.

It was found that flies of various species, when heavily infested experimentally, died off rapidly, being sickly during captivity. No doubt a similar circumstance occurs under natural conditions, so that, in all probability, it is only when flies are bred in lightly infected material that they are able to survive for any length of time as infected insects. This is probably a partial explanation of the low percentage of parasitized captured flies. One must not overlook the possibility of the larvæ originally present having all escaped from an infected fly before the latter was captured.

It was observed that native species of *Musca* became much more heavily infested with *Habronema* than the house fly did when placed under similar conditions. This remark applied to both *M. vetustissima* and *M. fergusoni,* the only two tested for the purpose. Eggs of the house fly and *M. vetustissima*, laid on the same day, were placed together in a jar containing horsedung known to be infected with *Habronema,* fresh material being added when necessary, always from the same source. *M. vetustissima* emerged some days before *M. domestica*, owing to its shorter larval periods, and on examination all (22) were found to be parasitized, the number of worms counted ranging from 39 to 97, with an average of 71. In the case of the house fly, 46 were collected, 36 (*i.e.*, 78 per cent.) being infected, the parasites ranging in number from 1 to 20, with an average of 4.4.

Habronema microstoma.

Both Hill and Bull have already shown that the stable fly (*Stomoxys calcitrans*) is apparently the normal transmitter of *Habronema microstoma,* and does not become parasitized by either of the other species.

We might mention that, though the horsedung used in our experiments in Brisbane contained all three species of *Habronema*, *H. microstoma* was found only in *Stomoxys*, while the other two species did not develop in this fly, but parasitized *M. musca domestica*, *M. terræreginæ* and *M. hilli*, which were bred out from material from the same source, and sometimes from the same material. It is unlikely that either *M. vetustissima* or *M. fergusoni* would serve as hosts for *H. microstoma*, though it is quite likely that the buffalo fly (*Lyperosia exigua*) could do so.

Escape of Habronema from Flies.

It was previously thought that the tiny worms escaped from the fly and gained access to the horse's stomach (where further development occurs) as a result of accidental swallowing of dead or living infected insects during feeding, the worms becoming liberated as a result of digestive agencies. It was suggested as a possibility that they might escape by rupturing the fly's proboscis in a manner similar to that by which final embryos escape from mosquitoes.

We have been able to prove that the larvæ can escape from the proboscis of infected flies belonging to several species when the latter are feeding on saliva. In other words, larvæ can make their exit when flies are frequenting mucous surfaces, *e.g.*, mouth, nose, eyes, or even sores and wounds. They would readily pass through the mouth, to eventually reach the stomach of the horse, there developing to maturity after undergoing a series of moults. Should the larvæ escape to the conjunctiva, or into a sore or abrasion, or even the wound made by some biting fly, then a habronemic granuloma might be produced, such, for example, as those described by Bull, Railliet, and others. In the case of *Stomoxys*, *Habronema microstoma* might escape directly into the tissues during the puncturing by the fly. Of course, the larvæ which are deposited elsewhere than in the vicinity of the mouth, ultimately perish, though before doing so they may set up the inflammatory condition which at length results in a granuloma, or perhaps even swamp cancer.

The chief transmitter of equine granuloma is probably not *Musca domestica*, but *M. vetustissima* and *M. fergusoni*, together with *Stomoxys*, though the house fly is perhaps mainly responsible for its occurrence in stabled animals. *M. domestica* prefers shade conditions, and does not worry horses and stock like the two species of *Musca* just mentioned. The latter are essentially outdoor flies, and occur in such incredible numbers in drier areas (especially after rain) as to constitute veritable plagues, which worry man and beast alike, invading the mouth, eyes, nose, food, &c. The most widespread abundant Australian fly appears to be *M. vetustissima*, but in the northern parts of the continent (from about 25° S. northwards), *M. fergusoni*, a larger fly, seems to be the more common.

The life histories of the four native species of *Musca* referred to in this article have been recently worked out by Miss Bancroft and the author, the results having been published in the Proceedings of the Royal Society, Queensland, 1919 (*M. fergusoni* and *M. vetustissima*), and the Memoirs of the Queensland Museum, 1920 (*M. terræreginæ* and *M. hilli*).

Scientific and Technical Societies.

Abstract of Proceedings.

LINNEAN SOCIETY OF NEW SOUTH WALES.

At the May meeting (Mr. J. J. Fletcher, M.A., B.Sc., President, in the chair), the following papers were read:—

1. Report on the Neuropteroid Insects of the Hot Springs Region, New Zealand, in relation to the problem of trout food. By R. J. Tillyard, M.A., D.Sc., F.L.S., F.E.S., Linnean Macleay Fellow of the Society in Zoology.

Examination of the contents of trout-stomachs showed that the most abundant foods were the Green Manuka-Beetle, *Pyronota festiva*, the larvæ of Caddis-flies of the family *Leptoceridæ*, and the small mollusc, *Potamopyrgus* sp. Less abundant were larvæ of Dragonflies, Mayflies, Stoneflies, other families of Caddis-flies, &c. Since the introduction of the trout the insect fauna of the region has been very greatly reduced, the percentage reduction being estimated as follows:—Mayflies, over 50; Stoneflies, 80; and Caddis-flies, 90. In the vicinity of a few streams to which the trout have no access, insects are still comparatively very abundant. Suggestions for improving the position are made along two lines:—(i) improvement of the food supply, (ii) reduction in the number of trout.

2. The Panorpoid Complex. Additions to Part 3. By R. J. Tillyard, M.A., D.Sc., F.L.S., F.E.S., Linnean Macleay Fellow of the Society in Zoology.

Additional evidence is brought forward from the study of the pupal tracheation of *Morova* (*Siculodes*) *subfasciata* (Walk.) to support the conclusion that it is unlikely that any existing Heteroneurous type represents even a close approximation to the original archetype of the Rhopalocera.

Notes and Exhibits.

Mr. F. H. Taylor exhibited specimens of *Lucilia fucina* Walker, *Neopollenia papua* Walk.—both recorded for the first time from Australia, the former being originally described from South Africa, the latter from Papua. *L. fucina* is one of the sheep-maggot flies in Queensland, and probably in other States, and seems to have been confused with *L. sericata*.—*Chrysomyia rufifacies* (Macq.), *C. varipes* (Macq.), and *Ophyra analis* Macq., also sheep pests, *C. dux Esch.*, *Lucilia solaia* Walk., *Pyrellia naronca* Walk., and *Chaetodacus tryoni* (Frogg.), a fruit fly which breeds in grenadillas in North Queensland; also *Binellia tayloriana* Bezzi and *Euprosopia punctifacies* Bezzi.

Mr. E. Cheel exhibited specimens taken in October last, from a cultivated plant of a so-called double flowering peach-tree (*Prunus persica* var. *dianthi flora*), showing, in addition to the ordinary flowers with an increased number of sepals and corresponding number of petals and single pistils, quite a number of flowers with two, three, and four carpels distinct from the calyx and from each other in the one flower. An illustration, together with a note, is published by M. J. Berkeley in the *Gardener's Chronicle* for 1852, p. 452, of a similar occurrence in a "Golden Drop Plum," but the number of carpels according to the drawing was usually two, or occasionally three, in the one flower. Kerner and Oliver (vol. ii, p. 548) refer to this peculiar growth under the term "Antholysis," whilst Berkeley's drawing and note is quoted by Masters (Teratology, p. 365, fig. 186), under the term Polyphylly of the flower. Worsdell (The Principles of Plant Teratology, vol. 2, p. 93, 1916) mentions that in double flowers of the cherry, two carpels are almost invariably present. Daydon Jackson defines the term "Antholysis" as a loosening or a retrograde metamorphosis of a flower.

Mr. A. R. McCulloch exhibited a small collection of fishes recently presented to the Australian Museum by Mr. David G. Stead, general manager of the State Trawling Industry. These had been trawled in 150 fathoms, east of Sydney, on the edge of the continental shelf, and included several species not hitherto recorded from New South Wales waters.

Mr. A. A. Hamilton exhibited a series of specimens of Aroids from the National Herbarium, illustrating Chromatism, Virescence, and Multiplication of Spathes. (1) *Anthurium chelsciensis* Hort., Botanic Gardens, Sydney (E. N. Ward, April, 1914). (2) *A. Andreanum* Linden, "Uralla," Concord (J. H. Horton, July, 1917). In both examples the highly coloured pigment, which under normal conditions covers the spathe, is only partially developed. On a portion of the surface the chlorophyll is disclosed (virescence) indicating the leafy origin of the spathe. In the example of *A. Andreanum* the spadix is suppressed and the spathe slightly malformed. (3) *Richardia africana* Kunth., Manly (W. Ellison, August, 1914), showing (*a*) a coloured leaf (chromatism) on the flower stem stimulating the spathe, (*b*) drawing by Miss M. Flockton of a flower grown at Summer Hill by Mrs. W. H. Hughes, depicting a supernumerary spathe, enfolding the normal floral envelope. (4) *Richardia Elliottiana Pentlandii*, Sydney Botanic Gardens (C. Woolnough, January, 1920) from a seedling raised by H. H. B. Bradley. In this example the colouring pigment of the spathe is partially developed in the supporting leaf. Worsdell (Prin. of Plant Teratol., i, Pl. xvii) figures a similar example of chromatism in *R. Elliottiana*, and it is interesting to note that a seedling of this stock raised in Australia has perpetuated the abnormality.

Mr. Fletcher exhibited a remarkable leaf of *Jacaranda ovalifolia*, 12½ inches long, apparently bifurcated apically for 3 inches, one branch having 9½, and the other 8½ pairs of pinnæ, with 13½ pairs of pinnæ on the undivided proximal portion; and he raised the question whether it was really a case of division of the growing point; or, seeing that the apparent bifurcations have pairs of pinnæ, whether it was a case of the incomplete fusion of two leaves. He showed also flowering branches of *A. discolor* with leaves with one pair, two pairs, and three pairs of pinnæ; leaves of advanced seedlings which had not yet flowered, with ten and eleven pairs of pinnæ; and reversion-shoots and seedlings of euphyllodineous Acacias, to illustrate the importance of taking account of the terminal setæ.

ROYAL SOCIETY OF QUEENSLAND.

At the April meeting, Mr. J. B. Henderson, Government Analyst, called attention to the records of proved petroleum occurrences in Queensland. Liquid petroleum has been found on the water from several bores, particularly around Longreach. This liquid solidified on being removed from the hot bore waters. Three samples of the petroleum wax from bores were shown by the lecturer. He also stated that it was definitely known that the gas which was obtained at the Roma bores was petroleum gas, and not coal-seam gas. It possibly carried a recoverable proportion of petrol. It is, therefore, quite definite that both solid and gaseous petroleums occur in Queensland, but, so far, no samples have been found of liquid petroleum from which petrol and kerosene could be distilled. Kerosene shales were not included by the lecturer in petroleum deposits, as these shales have to be distilled ere they yield oil. The most interesting deduction made by the lecturer was that it is practically certain that those bores on the water from which petroleum was found had passed through oil deposits, and that had the water in the bore been pumped out oil would have been obtained. These oils were all obtained from great depths—from 3,000 to 6,000 feet—where the enormous pressure of the water in the bore would be likely to drive the oil away from the bore. After a short time all the oil would be driven away, perhaps never to be recovered, possibly to be recovered at a later date.

There are instances in America where bores have been abandoned as failures, but, later on, when pumped out, have yielded good oil supplies. The higher pressure of water in the bore had driven the oil away. Exactly these conditions were certainly established in Queensland in some of the bores where oil was seen on the water. The lecturer demonstrated by a simple piece of apparatus how oil or gas can be bored through and missed, how only small quantities are occasionally obtained while boring, and then no more comes up when

boring ceases; how sometimes the oil is driven quite away from the bore and lost; and in other instances driven away and yet can be recovered; and the probable cause of the stoppage of the gas flow in the Roma bores. The most interesting point in the lecture was the demonstration of the certainty of the occurrence of petroleum in Queensland, though, unfortunately, so far only the least valuable fractions—the solid and gaseous petroleums—have been found. It is, however, highly probable that where these occur the more valuable liquid fractions cannot be altogether absent. The necessity for all well-borers regularly reducing the pressure while boring, by pumping out the water in the bore casing, is also evident. Had this been done in the past, we would almost certainly have had a flourishing petroleum industry in Queensland by this time.

ROYAL SOCIETY OF WESTERN AUSTRALIA.

At the May meeting of the Royal Society of Western Australia, a paper on Western Australian Ants' Nests was read by the secretary for Mr. J. Clark. This paper was the first of a series embodying the results of Mr. Clark's researches on the species found as guests in ants' nests in this State. Spiders, mites, wood lice, and a few flies occur, but by far the greater proportion of species found were beetles. An interesting nest is that of *Iridomyrmex conifer*, the twig Mound Ant, in whose nests many species were collected. The twig mounds are composed of grass and sticks, and are the ants' winter quarters. In summer the ants, apparently aware of the danger of fires, which frequently burn their homes, forsake them, and excavate a nest close by. The two nests are so dissimilar that they appear to be the work of distinct species, one a mound builder, and the other a miner. The next winter nest is built over the summer one, or sometimes over a small plant or an old root. There are several entrances, at which some ants always appear to be mounting guard. Some ants also found in the eastern States, *e.g.*, *Ecatomma metallicum*, do not appear to harbor as many guests in their homes as do their eastern relatives, but further investigation is needed to investigate this point.

The Government Botanist (Mr. D. A. Herbert, M.Sc.) read a paper describing a new species of *Isopogon* from Cranbrook, and also recording some new species of fungi. One of the most interesting of these was a *Lysurus*, a fungus with the rays of its fruiting body covered with a fetid slime, in which are embedded the spores. Blowflies and other flies of various kinds feed greedily on this, and the spores, passing through their alimentary canals undigested, are scattered far and wide. The food value of the slime is very slight, as flies and maggots fed on it die in a day or so of starvation.

ROYAL SOCIETY OF TASMANIA.

At the May meeting, a paper on "*Nototherium mitchelli*, a Marsupial Rhinoceros," by H. H. Scott (Curator, Launceston Museum), and Clive E. Lord (Curator, Tasmanian Museum), was read.

The discovery at Smithton, during the present year, of a nearly complete skeleton of *Nototherium mitchelli* forms the occasion for a revision of many of our ideas respecting these remarkable marsupial animals, since the fragmentary remains hitherto available for study have failed to yield the sequence of evidence we now possess. This is a note only—intended to place upon record the fact that *Nototherium mitchelli* was an extinct marsupial rhinoceros, and that the four genera, *Nototherium*, *Zygomaturus*, *Euowenia*, and *Sthenomerus*, with their several species, are accordingly under revision, and will later on be dealt with in detail. The enormous mass of material to be passed in review forbids anything like speculation at present, but it is within the mark to observe that two groups of these animals have been instinctively felt (by all workers) to have existed, quite irrespective of sex questions—one a platyrhine and the other a latifrons type, and that it now appears that they were also a horned and a hornless group, and that *Nototherium mitchelli* belonged to the former, or cerathine group, and that some other species constituted the acerathine group, in which the weapons were reduced to very small things, or actually missing.

ROYAL SOCIETY OF SOUTH AUSTRALIA.

At the May meeting, a paper by T. Brailsford Robertson, Ph.D., D.Sc. (Professor of Physiology and Biochemistry in the University of Adelaide), on "Studies in Comparative Physiology 1. Observations on the Physiology of the Fly's Intestine," was read. The intestine of an insect represents a rhythmically contracting automatic structure, in which the contractile elements are striated muscle fibres. In the mammalia, on the contrary, all rhythmically contractile organs, with the exception of the heart, are composed of smooth muscle fibres. The fly's intestine, therefore, affords an opportunity of ascertaining whether the behaviour of striated and smooth muscle fibres towards various muscle stimulants or depressants is determined by their structure, or, on the contrary, by the nature of the functions which they perform. The author finds that there exists in the fly's intestine, a gradient of Ca/Na thresholds above and below which contractions or peristalsis cannot occur, and between which lies an optimum ratio. The thresholds and optimal ratios increase from the rectal extremity upwards, being least in the posterior rectum and highest in the distal intestine. In its reactions to Curari, Atropine, Nicotine, Pilocarpine, Codeine, Chloretone, Adrenaline, Ergotoxine, Ergostonine, Ergamine, Digitaline, and Pituitrine, the muscle of the fly's intestine resembles its functional similar, the vertebrate smooth muscle fibre, rather than its structure similar, the vertebrate striated muscle fibre.

Essential Oil from Native Pine, South Australia.

By H. H. Finlayson (communicated by Prof. Rennie, D.Sc.).

The tree yielding the oil here described was found in fairly dense scrub near Tailem Bend, and about 85 miles south-east of Adelaide. It attracted attention on account of its very numerous fruits, and the unusually large quantity of oil which these contained.

Specimens of fruits and foliage were submitted to Mr. Maiden, Government Botanist of New South Wales, and were pronounced by him to be characteristic of *Callitris verrucosa*.

On steam distillation of the fruits, a nearly colourless oil, of turpentine odour, was obtained in a yield of 2.49 per cent.; the yield recorded for this species by Baker and Smith (*Pines of Australia*), is .44 per cent.

The oil had the following constants:—

$$D^{12}_{12} = \cdot 8674. \qquad [\alpha]_D^{18} = -19\cdot 3^\circ.$$

$$\text{Esters} = 2\cdot 9\,\%. \qquad \text{Alcohols} = 1\,\%.$$

[α] Pinene was present to the extent of 85–90 %, the laevo modification predominating, but the remaining constituents were not identified with any certainty owing to the small quantity available.

ROYAL SOCIETY OF NEW SOUTH WALES.

At the June meeting, Mr. R. H. Cambage, F.L.S., read a paper on "A New Species of Queensland Ironbark." This new Eucalyptus comes from about 120 miles westerly from Cairns, in tropical Queensland, and furnishes a good red timber. It was found growing on granite formation in open forest country, and resembles *E. crebra* in bark and timber, but differs in the shape of buds and fruits, which latter are hemispherical, with exserted valves.

Henry G. Smith, F.C.S., and A. R. Penfold, F.C.S., Technological Museum, Sydney, contributed a paper on the "Manufacture of Thymol, Menthone, and Menthol from Eucalyptus Oils." Work was undertaken in order to determine the molecular structure of Piperitone, the peppermint ketone of Eucalyptus oils. Piperitone is a menthenone with the carbonyl group in the 3 position. When oxidised with ferric chloride in the ordinary way, 25 per cent. of thymol was produced. By reducing piperitone with hydrogen in the presence of a nickel catalyst, an almost quantitative yield of menthone was obtained, which, on further reduction with sodium in aqueous ether, produced menthol. The abundance of piperitone obtainable from *Eucalyptus dives* makes this ketone probably the best source for the manufacture of thymol and menthone.

Personal.

MR. DAVID AVERY, M.Sc.

David Avery, M.Sc., whose photograph is reproduced in the frontispiece of this number, was born in the Ballarat district of Victoria. In his boyhood he attended the Mount Pleasant State School, which at that time numbered amongst its scholars a group of boys who afterwards individually became distinguished Victorian citizens. While attending school his natural bent for science manifested itself in the winning of a scholarship in the Ballarat School of Mines, where he attended a class in chemistry under Professor A. Mica Smith. His early leanings towards science were, however, not allowed to interfere with his general education, and he afterwards won a Government Exhibition, as the result of which he entered Grenville College, Ballarat.

Three years later, having matriculated with honours in classics and mathematics, he won a Resident Scholarship at Queen's College, and entered the Melbourne University, taking the science course, with chemistry as chief subject.

At the University his earlier successes were repeated during his undergraduate years, and in his final year he was awarded not only the Final Honours Scholarship, but also the Kernot Research Scholarship and the Wyselaskie Scholarship in Chemistry. He graduated B.Sc. in the year 1892.

The two following years were spent in carrying on research work in the University laboratories under the guidance of Professor Orme Masson. About this time he was appointed science tutor to Ormond, Queen's, and Trinity Colleges, Owing to the happy facility with which he expresses himself, and to his power of imparting to others the knowledge he has acquired, he was very popular as a teacher. In the year 1894 he was admitted to the degree of Master of Science.

On entering the University he went into residence at Queen's College, where he remained for the whole of his academic career. His personal qualities soon won for him a leading position in the social life of his college and the University. He rowed in his college " eight," and played with his college " eleven."

On leaving the University Mr. Avery, at the instance of Mr. Hans Irvine, took over the general management of a group of metallurgical works for the extraction of gold by the McArthur-Forrest cyanide process, his head-quarters being at the Black Horse Gold Mining Company at Mt. Egerton, near Ballarat. He occupied this responsible position for about two years. The sands under treatment were of low grade, but under Mr. Avery's management the gold extraction process was carried on most successfully.

In 1899 a department of chemistry was established at the Working Men's College (now the Melbourne Technical School), and Mr. Avery was appointed as head of the department. He devoted himself to his new work with energy and enthusiasm, and his efforts were rewarded with almost phenomenal success. The growth of the department was

very rapid. As a teacher his lectures were characterised by clearness, and he displayed a boldness and originality in his manner of illustrating the abstract principles of chemical science which were much appreciated by those who sat under him. The course of instruction covered a wide field, and included both pure and applied chemistry. For his work at the Working Men's College he was peculiarly fitted, owing to his sound general and scientific training, supplemented by research experience and matured by industrial experience in the control of large-scale chemical and metallurgical operations. Added to this were great organizing ability and a personality which assured the maintenance of most cordial and friendly relations between the lecturer and his students. Most cordial also were his relations with his colleagues, many of whom look back upon that period with the greatest pleasure. His influence upon the young men who sat under him as day students doing engineering and chemistry courses—most of whom now hold responsible positions in Australia and elsewhere—was very marked, but perhaps the lectures he delivered in the evenings were most appreciated. To these men of all types were attracted by his reputation as an exponent of chemical science. They included both young men and old, professional men and ambitious holders of clerical positions; also proprietors, managers, foremen, and workmen from manufacturing establishments, as well as schoolmasters and teachers, and such diverse types as University graduates and almost illiterate "practical" men.

Mr. Avery is an indefatigable worker. While building up the chemistry department of the college, equipping its laboratories, and lecturing both in the day and evening, he found time to carry on research work, especially in connexion with practical problems relating to the industries. In addition he was frequently consulted by manufacturers and others, who wished to obtain his advice on their problems.

Mr. Avery is a leading educationalist, and has done much to advance the cause of technical education in Victoria.

In 1908 he obtained leave of absence from college duties, and made an extended tour of the Continent and England, where he studied at first hand various chemical problems and visited the principal universities and technical schools. Returning to Australia in 1909 he again took up his teaching duties, but in 1911, after twelve years, during which the department of chemistry had grown from small beginnings to a very large establishment, he resigned his lectureship in order to devote himself to private practice as a consulting chemical and metallurgical engineer.

As a consultant he has done much to assist in the establishment and improvement of Australian chemical industries, and he is closely associated with some of the largest and most progressive Australian companies.

He has for many years been connected with the development of processes for the metallurgical treatment of ores by flotation, and in the war period he spent much of his time at Broken Hill, New South Wales; Port Pirie, South Australia; and Risdon, Tasmania, investigating important problems relating to the production of lead and zinc, which were so urgently required for munition making. During this

time, and subsequently, he has had a large share of the responsibility of directing and supervising the investigational work in two of the largest industrial research laboratories in Australia.

Mr. Avery is chemical adviser to the Melbourne and Metropolitan Board of Works, which controls Melbourne's water supply and sewerage systems.

Notwithstanding his numerous professional activities, he devotes considerable attention to public affairs, especially to educational matters. Mr. Avery is a man of culture in the wider sense, but he is a firm believer in science as a cultural subject, if it is taught in the right way. On his retirement from the Working Men's College he was appointed Government representative of the Council of the College, and he is now senior vice-president of that body. He is also vice-president of the West Melbourne Technical School. He was one of the founders of the Society of Chemical Industry of Victoria, of which he is also a past president. He is a member of the Food Standards Committee under the Victorian Health Act 1919.

On his return from Tasmania in the beginning of 1919 Mr. Avery was appointed a member of the Executive Committee of the Advisory Council of Science and Industry, and has devoted much time and attention to the work of the Institute.

At the May meeting of the Royal Society of Tasmania His Excellency Sir William Allardyce, K.C.M.G., took the chair as President for the first time. Major L. F. Giblin, D.S.O., was elected a member of the Council in place of Mr. T. W. Fowler (resigned).

Messrs. H. Tryon, A. Cayzer, B.Sc., and L. E. Cooling have been elected members of the Royal Society of Queensland.

The Council of the Linnean Society of New South Wales has elected Messrs. C. Hedley, F.L.S., W. W. Froggatt, F.L.S., A. G. Hamilton, and Professor H. G. Chapman, M.D., B.S., as Vice-Presidents; and Mr. J. H. Campbell (Royal Mint, Sydney), as Hon. Treasurer for the current session, 1920-21.

Professor R. D. Watt, M.A., B.Sc., has been re-elected President of the Sydney University Agricultural Society. Other officers elected were Messrs. J. H. Maiden, I.S.O., F.R.S., F.L.S., C. O. Hamblin, B.Sc. (Agr.), R. J. Noble, B.Sc. (Agr.), P. Hindmarsh, M.A., B.Sc. (Agr.), Vice-Presidents; S. Cook, Hon. Secretary and Treasurer; and T. H. Harrison, Assistant Secretary.

After an absence of fifteen months in the United States of America and Great Britain, Professor Kerr Grant (Professor of Physics at the University of Adelaide), recently returned to Adelaide. Professor Grant spent several months in the research laboratory of the General Electric Company at Shenectody, New York, and was specially engaged upon the application of X rays, chiefly to the analysis of metals and other crystalline substances.

REVIEWS.

Coal Tars and their Derivatives.—Dr. G. Malatesta, pp. xi. + 530, with 180 illustrations. Translated from the first Italian edition, with revisions, corrections, and additions by the author. E. and F. N. Spon Ltd., 57 Haymarket, S.W.1. This work forms a valuable addition to the useful series of handbooks published by E. and F. N. Spon for the use of technical chemists. The author devotes an initial statement to an historical account of the methods for extracting by-products from coal, and shows the prime importance of the coal-tar industry as a source of artificial colours and other valuable synthetic products. In the chapters on tar obtained from the manufacture of illuminating gas and of industrial coke, the various technical processes are described. Under "Tar Compounds" theories of the formation of tar are discussed, and the properties of the different series are given. Tar distillation, light oil, pitch, and the distillation of lignite (brown coal) tar are other subjects dealt with. The concluding portion of the work gives an analysis of fuels from the point of view of their by-products.

The Outlook for Research and Invention.—N. M. Hopkins, M.Sc., Ph. D. (pp. + 241), with six full-page portraits, New York, D. Van Nostrand Co., 1919. The author, who is an experimental and research engineer and assistant professor at the George Washington University, states that his object in writing this book is to stimulate a more general interest in the broader and more comprehensive American research and to add toward lifting its inefficiency, its national worth, and the educational requirements to those new in the field and in pointing out the many snares and pitfalls awaiting the unwary inventor. It is evident that the author is well qualified to carry out his object, both from the point of view of scientific training and from experience in research work in connexion with the extensive American war researches and also his varied experiences abroad, in his endeavour to overcome the "shut-in feeling in a Washington laboratory" in 1914 by travelling abroad and working in other experimental shops to "note the progress in other laboratories, research standards, factories, and production method." He travelled through Germany early in 1914, and was caught in Russia during the mobilization. One of the most pleasing features is the style of printing that has been used. A larger and heavier type has been used than is generally the case, and use has been made of italics, also of a corresponding clear type. This, of course, means fewer lines (30) to the page, which must result in an increase in the cost of production with the high rates of paper. There can be no question, however, as to the advantage to the reader. There are six full-page portraits much above the average with a short biography on the covering leaf of each. The publishers are to be congratulated on their work. The text is divided into eight chapters, each of which is complete in itself. The author is a free lance, and writes in the first person, making full use of quotations of distinguished scientists and scholars. He does not fail to criticise either destructively or constructively, or to reflect the views and comments of many brilliant men with whom he has had associations. He gives a fair comparison of the scientific achievements of men of various nationalities and has trite criticism for much of the past American work. His impartiality and free criticism should result in a careful analysis of the main subjects on which he writes. These may be seen from the headings of the chapters—

(1) The Spirit of Research, (2) Men of Research and their development, (3) Some indifference of the past, (4) American war research, (5) The education for research, (6) Some border-line limits, (7) Research in the Factory, (8) The making and protecting of inventions.

An appendix gives a great number of problems awaiting solution. These cover chiefly engineering (especially electrical), physical, and chemical investigations, and many have been suggested by well-known leaders in research. The work is written in a refreshing non-technical style, and should be read by every thoughtful reader. Net price $2, our copy from Messrs. Angus and Robertson Ltd.

The Theory and Practice of Aeroplane Design.—By S. T. G. Andrews, B.Sc., and S. F. Benson, B.Sc., London, Chapman & Hall, 1920 (pp. xii. + 454). 15s. 6d. This book is published as one of the Directly-Useful Technical Series which is intended to occupy a midway position between theoretical books written primarily for the training of students and practical books which omit the scientific basis upon which all good practice is built. The need of a reliable text-book on the theory and practice of aeroplane design has long been recognised by all those connected with aeronautical affairs. The present volume aims to supply this want, and will be found useful by designers, aeronautical draughtsmen, and students, besides containing much of interest to the general reader.

The study of aeronautics can only be successfully attempted by those possessing a good knowledge of mathematics and physics. Aeroplanes are machines containing many differing elements. These elements demand a great or less amount of scientific knowledge according to their nature. In order to become an aeroplane engineer and designer it is necessary to have a thorough knowledge of (*a*) the graphic representation of laws showing the relationships which exist between the various quantities; (*b*) the fundamental theorems in theoretical mechanics, such as those dealing with velocity, acceleration, gravity, moments of inertia, centrifugal force, fluid motion, work, energy, and power; and (*c*) various theorems in applied mechanics in their bearing upon aeronautical problems.

The first chapter of the book deals generally with the question of principles of design. Chapter 2 deals with constructional materials, including timber, light alloys, steel, and aeroplane fabric. Tables are given showing the standard specifications for steel and the Brinell Hardness numbers. The method of preparing stress diagrams for the different components of an aeroplane is also lucidly explained. Chapter 3 is devoted to the proportions of aerofoils, and interesting descriptions are given of the experimental work carried out in the wind tunnels at the National Physical Laboratory and at the laboratories of Monsieur G. Eiffel, at Auteuil. Chapters 4, 5, and 6 deal respectively with Stresses and Strains in Aeroplane Components, Design of the Wings, and Resistance and Streamlining. In chapter 7 problems connected with the Design of the Fuselage are considered, while the following two chapters deal respectively with the Design of the Chassis and of the Airscrew. The latter problem has been approached both by analytical and empirical methods. The method of analytical attack adopted by the authors is that known generally as the "blade element theory," involving the consideration of the actual forces set up upon the blades, and based upon laboratory experiments upon aerofoils. Chapter 10 deals with the question of stability, which is closely interconnected with the question of controlability; while Chapters 11 and 12 deal respectively with the Design of the Control Services and Performance. In Chapter 13 the principles enunciated are applied to the lay out of a complete machine.

From the above it will be apparent that the whole subject is presented in a complete and logical manner. The value of the book is greatly enhanced by the inclusion of a large number of carefully prepared diagrams and tables which will prove of direct utility to persons engaged in aeroplane design. A special feature has also been made of illustrative examples, a large number of which are scattered throughout the text. In every way the volume is an excellent production.

Modern Roads.—By H. P. Boulnois, M.I.C.E., &c., London, Edward Arnold, 1919. (Pp. vii. + 302.) In the preface the author states that he has endeavoured to deal with the subject of roads in as comprehensive a manner as is possible, bearing in mind the constant improvements in methods of modern road construction that are now taking place. The first chapter deals generally with the importance of the road question, and it is pointed out that highway engineering is now a new profession involving knowledge of chemical and physical analysis, of the formation of the earth's crust, and of the character and formation of its rocks, as well as of the location and construction of highways. This fact is too often overlooked in Australia. The other chapters of the book are devoted to Traffic,

Waterbound Macadamised Roads, Tar Treatment of Road Surfaces, Bituminous Roads, Bituminous Carpets, Waves and Corrugations, Paved Streets and Concrete Roads. Mr. Boulnois points out that the attempts made in Great Britain to construct hard-surfaced concrete roads have not met with much success, although in the United States of America, Canada, and elsewhere many millions of square yards of roads of this form of construction have been laid. It is estimated that upwards of 50,000,000 square yards of such roads exist in America alone, and that, with few exceptions, they are a success. He ascribes the failure of these roads in England to lack of accurate knowledge of the behaviour of concrete and of methods of manufacture to suit the conditions. The book contains numerous definitions and specifications for various road-making materials. It is exceptional in that it contains neither cost data nor reproductions of highway photographs. The former are excluded owing to the present fluctuation in material and labour costs, and the latter because "they are of little practical value." The volume is well printed and the contents are clearly articulated. It forms a valuable contribution on a subject which is of very great interest and importance in Australia.

Foot Care and Shoe Fitting.—By W. L. Mann, M.D., and S. A. Folsom, M.D., pp. 124, with 58 illustrations. P. Blakiston's Son & Co. Philadelphia. The close association of the authors with the United States Navy has enabled them to draw their data from a variety of sources, and the result is a useful book of reference for officers interested in the marching capacity of their troops. The care of the feet is of no less importance than the fit of the boots, and both aspects of the problem are fully discussed. The treatment of the different ailments of the feet is an important section of the book.

Animal Life and Human Progress.—Edited by Arthur Dendy, D.Sc., F.R.S. (Professor of Zoology in the University of London), pp. ix. + 227, Constable and Co. Ltd., London. The volume comprises nine lectures delivered at King's College, London, in 1917-18 under the auspices of the Imperial Studies Committee of the University of London. The joint purpose of the contributors was to emphasize and illustrate the importance of zoological science from the point of view of human progress, and judging by the results it is doubtful whether this could have been better accomplished. The subjects chosen are of intense interest and most attractively written. As Professor Dendy, in his article on "Man's Account with the Lower Animals," points out, the zoologist plays a great part, not only in the amelioration of the conditions of human life, whether in war or peace, but also in the education of the public with regard to many matters which have a very direct bearing upon the future of the human race. The utilitarian aspect of the study of zoology is, of course, emphasized, so that the vast material resources of the animal kingdom might be fully exploited in the interests of mankind, but the various contributors have invested their subjects with a live interest which cannot fail to open the eyes of any reader to the value of biological studies, the investigation of which alone renders possible the scientific study of man himself in all his manifold relations. The doctrine of organic evolution looms large in several of the lectures, and a certain advance is to be observed from the position held by Charles Darwin. However, if, as explained in a prefatory note, some of the views appear in some cases to be subversive of modern biological doctrine, it must be remembered that biological thought is progressive. Were it otherwise, the claims of biological science to a foremost place in our educational system might well be considered questionable. It is unnecessary to more than give the titles of the lectures, and their distinguished contributors, to reveal the pleasure and the profit to be derived from a study of the volume. The complete series is—"Man's Account with the Lower Animals," by Arthur Dendy, D.Sc., F.R.S.; "Some Educational and Moral Aspects of Zoology," by Professor Gilbert C. Bourne, M.A., D.Sc., F.R.S., Oxford; "Museums and Research," by C. Tate Regan, M.A., F.R.S., British Museum; "Man and the Web of Life," by Professor J. Arthur Thomson, M.A., LL.D., Aberdeen; "The Origin of Man," by Professor F. Wood Jones, M.B., D.Sc., London; "The Future of the Science of Breeding," by Professor R. C. Punnett, M.A., F.R.S., Cambridge; "Our Food from the Sea," by Professor W. A. Herdman, LL.D., D.Sc., F.R.S., Liverpool; "Some Inhabitants of Man and Their Migrations," by Professor R. T. Leiper, M.D., D.Sc., London; and "Tsetse Flies and Colonisation," by Professor R. Newstead, M.Sc., F.R.S., Liverpool.

REVIEWS.

SOME PUBLICATIONS RECEIVED.

Wheat Smuts and Their Prevention, with Notes on other Cereal Smuts and Ear Cockle (*Bulletin* 71).—By Mr. G. L. Sutton, Department of Agriculture, Western Australia.

The Custard Apple in Queensland, with Notes on its History and Cultivation.—By W. Leslie, Department of Agriculture and Stock, Queensland.

Journal of the American Society of Heating and Ventilating Engineers (March).—Special features are "Progress in Warm-air Furnace Testing," by A. C. Willard; the "Magazine Feed Down Draft Boiler," by E. C. Molby; "Work of the Construction Division of the Army," by R. W. Alger; "The Co-operative Movement," by J. P. Warbosse; and papers on "Drying of Food Products."

The Journal of the Institution of Electrical Engineers (February).—Principal contributions—"Failures of Turbo-Generators and Suggestions for Improvements," by J. Shepherd; "High Frequency Resistance of Wires and Coils," by Professor G. W. O. Howe; and "Electricity in Tin Mining," by D. M. W. Hutchison, B.Sc., and W. J. Wayte.

POSITION WANTED—ANALYTICAL CHEMIST.

No. 29 seeks a position of responsibility. Late Assistant Chemist, Department of Agriculture, Kuala Lumpur, Federated Malay States. Present position—Analyst in New Zealand Government Service. London training covers advanced work in organic and bio chemistry and in technical chemical analysis. Experience in dairy chemistry, foods and drugs, agricultural chemistry, medical chemistry, and chemical pathology, bacteriology, fermentation, and enzyme chemistry. Advertiser is a Fellow Chemical Society, Lond., Society of Chemical Industry, Biochemical Society, and the Royal Microscopical Society.

C/o "Enzyme,"
this Journal.

MR. A. E. LEIGHTON, General Manager, Commonwealth Arsenal, and a Member of the Executive Committee of the Institute of Science and Industry.

(For Biographical Notes, see page 445.)

SCIENCE AND INDUSTRY.

VOL. 2.] JULY, 1920. [No. 7.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Science and Industry Bill.

THE long-promised Bill for the permanent establishment of the Institute of Science and Industry has been introduced into the House of Representatives. As the Hon. W. Massy Greene in his speech on the second reading pointed out, the delay has not been altogether an unmixed evil, for it has served to emphasize the necessity for the creation of such an organization. Another point which ought not to be overlooked is that the temporary Institute, during the four and a half years of its existence, has been able to make a thorough survey of the scientific industrial problems of the Commonwealth, to initiate investigations into some of them, and to erect the machinery for a further extension of research activities immediately permission to proceed is given.

In one or two important respects the new Bill differs materially from the old one. Two provisions in the original measure which do not appear in the proposal now before Parliament were—

> 11. (1) An Advisory Council representing science and the principal primary and secondary industries shall be appointed in each State, and shall advise the Directors with respect to the affairs of the Institute.
>
> (2) The members of the Advisory Council in each State shall be appointed by the Governor-General, and shall receive fees and travelling expenses as prescribed for attendance at meetings.
>
> 12. One or more of the Directors shall meet and confer with each Advisory Council at least once a year.

Another departure from the original Bill is the substitution of one Director instead of three.

The reasons advanced by the Hon. W. Massy Greene for these alterations are that the new scheme of organization will prove much more effective and far less cumbersome than the former proposal. Rather than that the Institute's activities should be spread over a wide area in the first place, and that a little money should be spent here and a little there, it is the Government's intention to concentrate, at the outset, upon a few problems of outstanding importance. Advisory Councils in all the States would, therefore, be unwieldy and superfluous. Under the amended scheme, however, it is not proposed to dispense with advisory bodies, but to call to the aid of the Institute those men, both scientists and industrialists, whose experience bears directly upon the special problem in hand. To quote the Hon. W. Massy Greene:—"We have not included in this Bill statutory provisions for the appointment of Advisory Councils. The reason for this is that we feel that no one Advisory Council could cover the whole field of scientific research. It is contemplated that the Director, when appointed, will specialize his work, and that it will be necessary to appoint a special man to deal with such a subject as agriculture. That having been done, he would then call to his counsel men who knew something of the subject."

Questioned further by members on this point, the Minister proceeded—"The Bill, as previously framed, laid it down that there must be Advisory Councils. If, however, these Advisory Councils were to cover the whole field of scientific research in agriculture, mining, forestry, and manufacturing in all its branches, they would be so unwieldy as to render it impossible to obtain the best results. What is proposed is that, instead of having Advisory Councils created by Statute—which would mean that certain interests would have to be left unrepresented unless we were to make these Councils altogether unwieldy—the Director shall be left free to call to his counsel, in regard to the particular problems that have to be studied from time to time, such men as may be considered desirable. Mr. Richard Foster.—And he will be free to benefit from the existing work of the universities? Mr. Greene.—Certainly. It is thought that in this way we shall secure better and speedier results, and probably incur far less expenditure, than if we created Councils which, however large within reason they might be made, could not possibly cover the whole ground. That, briefly, is what we have in our minds, and it was that consideration which actuated the Government in removing from the Bill the statutory provision for Advisory Councils. Under such a system it would have been necessary to have a large number of men on a Council. Only one of that number might know anything of a

particular subject with which the Director was dealing, when, perhaps, he should have eight or nine men gathered from all parts of Australia to advise and assist him in regard to it."

These modifications of the advisory machinery have been made to conform to the initial requirements of the Institute. In an earlier part of his speech, the Minister indicated the necessity of commencing in a small way. He said—"The more study one gives to the subject, the more one becomes convinced of the absolute necessity for Australia doing what is possible, at all events, at the present moment, towards the establishment of an Institute of Science and Industry. We are obliged to cut our coat according to our cloth. If we had unlimited funds at our command, no doubt we could launch out and do vast and useful work for Australia by spending a very large sum of money in this direction, but we cannot do that to-day. We must proceed slowly along the road. However, notwithstanding the present financial position and the enormous commitments ahead of us, I do not think we ought to refrain from making a start in a direction in which so much useful work can be performed."

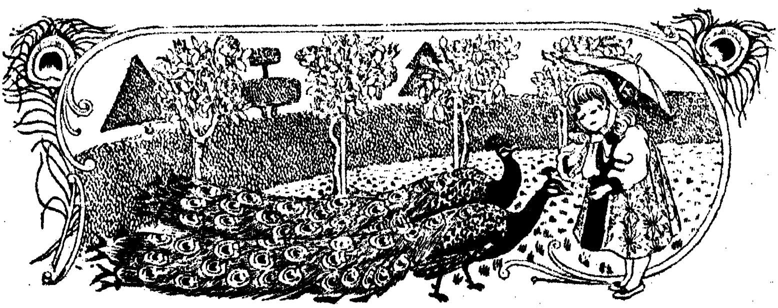
Apart from the alterations referred to, no other important amendments have been introduced. The powers and functions of the Director are identical with those it was previously proposed to confer upon the three Directors. Their scope is wide, and the only limitations will be those imposed by the amount of money at the disposal of the Institute. It has been abundantly demonstrated that, not only are the States disposed to co-operate with the Institute, but that they will welcome the opportunity, which the new Commonwealth organization must present, of uniting the divided and scattered scientific forces separately working upon the same problem, and of directing combined efforts towards the eradication of pests widespread in their incidence and ruinous in their ravages.

The Hon. W. Massy Greene made it clear that, far from desiring to create an Institute whose work would overlap that of State Departments, the Federal Government desired concentration and co-ordination of scientific work. He quoted from the speeches of the State Premiers who attended the 1918 Conference to show how that desire was shared as strongly by the State Governments themselves, and he reinforced his arguments with a number of examples of co-operative research being undertaken by the States and the temporary Institute. After indicating the extent of the development of similar organizations in other countries—Great Britain, United States, France, Italy, Japan, Canada, Sweden, and Belgium—the Minister for Trade and Customs referred to the very excellent service rendered by the Advisory Council of the temporary Institute. "Those gentlemen," he said "did a great deal of preliminary investigation work, and naturally, having laid the

foundation, they were anxious to see the edifice raised. They wanted to proceed; but, as the Minister charged for the time being with the administration of the Department, I felt that, until Parliament had definitely authorized the establishment of this institution, it would not be right for me, notwithstanding that we were not exceeding the vote passed by Parliament in respect of the year, to permit expenditure on work which would necessarily commit the country to expenditure in future years."

It is the intention of the Government that the new Institute should devote itself largely to problems primarily connected with agricultural industry. "Action in this connexion," said the Minister, "was originally suggested in this Parliament through a desire to help agriculture, and honorable members will recollect that many years ago the present Minister for Works and Railways (Mr. Groom) was associated in this House with the introduction of a Bill for the creation of an Agricultural Bureau. The purpose then in view is covered by the measure now under consideration, but I am satisfied that scientists can also assist our manufacturing industries very materially in the future."

E.N.R.



EDITORIAL

TOWN PLANNING.—"THE LIGHT" JOURNAL.

With genuine pleasure we draw attention to *The Light*, a journal to be devoted to furthering interest in town planning and housing. The South Australian Town Planning and Housing Association has rendered useful service to Australia in securing prominence for the movement which it has inaugurated; and if it has not succeeded in accomplishing all that it had hoped to do at this early stage of its existence, the Association can console itself with the reflection that the way of the reformer, as of the transgressor, is hard. The regular publication of accounts of its activities and its aspirations must tend to make progress easier. Apathy, lack of imagination, and the freedom given to the speculator, may retard the adoption of progressive ideas, but there is no better way of disposing of these hindrances than by well-directed propaganda. Australia, probably more than any other country, is in a position to benefit from a well-ordered, scientific, and attractive system of civic improvements. Great Britain, Germany, and the United States offer numerous instances of life made more pleasant by the improvement of housing conditions, and it must exercise a bad effect upon our national growth if we in Australia are to remain indifferent to modern developments in this direction. We have sunlight, fresh air, and space in abundance, and the aim of the Town Planning Association is to utilize these for the promotion of the happiness and contentment of city workers; to insure economic construction; and to eventually rid the cities and suburbs of some of their ugliness and squalor. In the country, also, conditions of life can be made more attractive by closer attention to fundamental principles, so that there lies before this new journal an enormous field of important and profitable work. The offices of *The Light* are at Alexandra Chambers, Grenfell-street, Adelaide.

POWER-ALCOHOL.

Some interesting facts in regard to a substitute for petrol made with alcohol distilled from molasses have been published by the Cuban Secretary of Agriculture from information which is based upon a report to the Planters' Association made by the Agricultural Company of Maui. A large portion of the molasses produced yearly in Cuba is now entirely wasted, only 60 per cent. of the total production in 1918, of approximately 150,000 tons, being used. The average price in 1918 was 35s. per ton. The Maui Company produces 350 gallons of alcohol daily, with only three men, and claims that a plant to produce 3,000 gallons per day would need no larger force. The alcohol, modified as a

substitute for petrol, has already been produced in considerable quantities by the Maui Company, and has been submitted to a number of trials, all of which gave excellent results. It left no deposit of carbon, but cleaned the cylinders of the machines in which it was tried of the carbon left there by petrol. The machine ran with less vibration, with less lubrication, and at a higher uniform velocity with the same opening of the valve that obtained with petrol. The fuel consists of a mixture of 100 gallons of alcohol with 5 gallons ether, 2 gallons of benzine, and 1 gallon of pyridine.

ECONOMIC BOTANY AND CHEMICAL INDUSTRY.

In an article in the May issue of the *Journal of the Society of Chemical Industry*, Professor J. B. Farmer, F.R.S., draws attention to the importance of more extended investigations into the best means of utilizing vegetable products as raw materials for industry. Few people sufficiently visualize how absolutely dependent we are on plants for the sheer necessities of life, or realize how urgent is the demand for investigations which will enable us not only to increase our wealth, but also give us a further measure of control over the sources of, and the conditions that affect, this plant revenue. Professor Farmer states that greatly increased recognition of the value of science in industrial enterprise is being given, not only in regard to chemical and engineering problems, but also in the biological sciences. He mentions such problems as those connected with the exploitation of oil, rubber, and other tropical products, fermentation industries, and immunity to fungal and other disease-producing organisms. He points out that both in the field and in the laboratory the amount of scientific work that is urgently needed in connexion with cotton alone is stupendous, and that the results will have an Imperial no less than a national influence and significance.

RESEARCH ON CONCRETE.

Many problems of great interest and importance in connexion with the use of concrete were discussed at a recent Convention of the American Concrete Institute. Special attention was given to problems relating to concrete house construction, so as to assist in solving the shortage of houses, and to the question of concrete roads, the increasing use of which has led to many developments in the United States. Attention was directed to the fact that concrete, as employed for many purposes at the present time, is a new material, the science and art of which have not been adequately developed. *The Engineering News Record,* in commenting on the proceedings of the Convention, describes concrete as "a changing science," for the report of the proceedings of the Convention seems to indicate that, even in America, where this material is used on a far wider scale than in this country, there is still much dissatisfaction as to our knowledge regarding it. Seeing the amount of attention and study the question receives in America, it is suggested that, in view of the extensive building operations that must be undertaken in this country, and bearing in mind the shortage of all building materials, the various aspects of concrete construction and design call for much fuller consideration than they have received up to the present.

EDITORIAL.

BORAX AS A PLANT POISON.

The cessation of potash imports during the war gave a great impetus to search for local sources of supply in various countries. Among the sources used on a somewhat large scale was that of Searles Lake, California, from which many tons were taken. In 1917, injurious effects were produced by some fertilizers, and it was found that borax was the cause of this. Investigations were undertaken at the Indiana Agricultural Experiment Station, and they showed that very small amounts of borax could produce poisonous effects on maize. In 1919, the United States of America Department of Agriculture began experiments with Searles Lake potash, which was found to contain 6.25 per cent., or $Na_2B_4O_7$, and investigations were carried out with potatoes and cotton. Whilst these experiments were in progress, many complaints were received from different districts, stating that great injury was being done by potash fertilizers. Investigations showed that in all cases borax was present. The greatest damage was done to germination. The quantity of borax sufficient to produce decided toxic effects is small compared with well-known poisons such as copper and arsenic.

SUBSTITUTE FOR TARTARIC ACID.

In these days of high prices for commodities which were at one time so cheap and plentiful, "substitutes" are being freely advocated and used, some with great success, states *The Chemical Age*. As an example may be mentioned tartaric acid, citric acid, and cream of tartar. These three articles are always in great demand for domestic and technical uses, and it is difficult to find an efficient substitute. However, a special preparation, technically called acid sodium phosphate, is now filling the gap caused by the dearness and short supplies of this important group of acid bodies. For many purposes where acidity only is required, acid sodium phosphate can effectively take the place of these acid bodies. Acid sodium phosphate is a pure, white, crystalline preparation, entirely soluble in water, possessing a greater acidity than cream of tartar, and is generally guaranteed to be in conformity with the Foods and Drugs Act. Its cost to-day is considerably less than prices asked for the three other acids whose place it effectively takes.

OIL OF PINE NEEDLES.

An interesting paper on essence of pine needles appears in the last issue of our esteemed contemporary *La Parfumerie Moderne*. Generally speaking, the term oil of pine needles comprises the essential oils derived, not only from the needle-shaped leaves of the trees, but also from the young shoots and cones (that is, the first-year buds) as well. The most highly esteemed essence is the Swedish, made, principally, in the neighbourhood of Jönköping. The raw material for distillation is really a waste product in the timber industry. When the trees are felled and lopped, women and children collect the *débris* and cut off the twigs, leaves, and cones, which are packed in large sacks and then carted to the distilleries. They are there chopped up into small pieces in order to facilitate rapid distillation. They are placed in wooden containers through which a rapid current of steam is passed. The essential oil collected is rectified, and is then a colourless oil, with

perhaps a faint greenish tint, and having the aromatic odour of the Scottish fir. The non-volatile residue left in the still after rectification forms the extract of pine, which is used for an adjunct to baths, and is used on a considerable scale for this purpose. The mountains of Thuringia and Southern Germany have, for many years, been an important source of essential oil of pine. The principal tree employed there is *Pinus pumilis.* The leaves, &c., are collected at the end of May and the beginning of June, and distilled in large cylinders with a false bottom, through which steam is rapidly passed. In the Austrian Alps there is also a considerable industry in the distillation of pine needles. The white fir—*Abies pectinata*—is used for distillation purposes in the Tyrol and in Switzerland. The essential oil of this tree possesses a very pleasant odour. The oil from *Picea excelsa* is of such poor odour that it is only useful for perfuming boot polishes and similar types of commodities. In the United States, the Government have for some years carried out a series of researches, with a view to determining the yield and composition of the volatile oils obtained from the leaves of the more important pines growing in the States, in order to utilize to the best advantage the waste material of the lumber trade, and at the same time lessen the danger of forest fires. Small stills, holding about 400 lbs. of the leaves, are taken to the necessary spots, and experimental distillation carried out. The apparatus consists of a copper cauldron, into which the chopped material is packed, with a grilled bottom, through which the stream enters. The distillation waters are repeatedly returned to the still, in order to obtain the maximum yield of the oil. The twigs and leaves are chopped up small, and distillation usually commences about two or three hours after the fire is first lighted. The complete operation usually lasts from seven to eight hours, when the still is emptied, and a fresh charge introduced. The yields of oil obtained from the principal types of pine leaves experimented on are as follows:—

	Per cent.
Pinus palustris	0.401
Pinus heterophylla	0.271
Pinus ponderosa	0.112
Pinus Lambertiana	0.084
Pinus sabiniana	0.088
Pinus contorta	0.234
Pseudotsuga taxifolia	0.163
Abies manifica	0.14
Abies concolor	0.128

The American industry is believed to have a big future before it.—*Oil and Colour Trades Journal.*

JAPANESE EXPANSION.

Recent developments in Japan which have brought about the large-scale commercial re-adjustment in that country are not to be viewed with great concern, according to a statement issued by the Guaranty Trust Company, of New York, but rather as a natural result of a very sudden industrial growth without full consideration of possible off-setting

conditions. Lacking the natural resources of other countries, and appreciating the advantages of an extensive expansion, Japan undertook a development programme that not only promised to tax her resources under normal conditions, but gave little heed to possible upward market fluctuations. With the phenomenal rise in the price of silver, the bubble burst, and Japan found herself in the predicament of having to meet her obligations in silver, obtainable only at a high rate. "It is neither surprising nor, on the whole, undesirable," continues the Guaranty Trust Company, "that the Japanese adjustment should come at an early date, and with a certain incisiveness. It clears the ground in Japan for the more orderly growth to which the country aspires, and for which its undoubted adaptability furnishes excellent material." That Japan is fully cognizant of the potentialities of large mineral holdings is evident from the fact that Japanese syndicates have already extended their activities into South America, and have secured coal-bearing lands, copper, silver, tin, and lead mines, and kaolin and other deposits in Chile, in addition to tin and other mines in Bolivia and Peru. One of the causes of "the error in judgment" seems to have been due to Japan's assumption of large commitments in the development of Chinese resources; but it appears obvious that the country has no intention of placing all its eggs in one basket, and having gained experience in what may be regarded as domestic affairs, there is little possibility of a repetition elsewhere.—*Engineering and Mining Journal.*

FUEL ECONOMY IN GERMANY.

Dr. A. Gradenwitz gives some particulars of what the Germans are doing in the study of fuel economy, states *The Technical Review*. Reference is made to the Fuel Research Institute, set up at Dusseldorf for the training of fuel engineers, and to the heating and ventilation department established at the Berlin Technical College, which deals with the fuel problem from a household stand-point. Professor Brabbee, the director of the new department, states that if it were possible to apply the results arrived at in the laboratory to all the dwelling-houses in Germany, a fuel saving of 25-30 per cent. could be effected. The stoves of the usual tile type used are tested against a standard stove in two special rooms fitted up in exactly the same way. After the test stove and the standard have been fired for the same time with exactly equal quantities of fuel, the changes in air temperature in the rooms are tested with thermographs. Another method consists in connecting up the less efficient stove with an electric fire, the current being controlled by the heat generated in the ordinary stove. The standard stove designed by Brabbee makes first use of all of the radiant heat and afterwards of the thermal conduction of the gases of combustion. Dampers are eliminated, and the air passing under the grate is previously heated in a separate chamber to 180° C. The new type of grate contains one small opening, into which is let a secondary opening covered by a regulating vane. A standard iron stove of a similar design has also been constructed for purposes of quick heating, and has shown satisfactory results. Boiler and central heating furnaces are tested in a similar manner. These plants were previously designed for a minimum external temperature and not for

a mean temperature. A Swiss engineer, Zuppinger, has designed a furnace in which, when the outside temperature is relatively low, the fire-space can be reduced by means of detachable walls and so save 15-25 per cent. of fuel. This type has also been tested at the Berlin Technical College, but no results are available.

TURPENTINE AND ROSIN: NEW INDIAN SOURCE.

"Boswellia serrata" is a tree of the Burseraceæ order growing in India, which in Gwalior has been tapped by the natives for generations for its resin. Its possibilities have been investigated recently by the Indian Forest Service, who estimate that the cost of collecting the resin is about 9s. per cwt., and that the annual output should exceed 27,000,000 lbs. in India. An experimental distilling plant set up at the Forest Research Institute produced from the resin turpentine oil, rosin, and gum. The turpentine oil is of very good quality, closely resembling American; varnish made from it is rather duller than that from American oil, but quicker drying. The rosin is also satisfactory, and was valued at from £20 to £22 per ton in London. The gum, however, is of doubtful value, being poorer than gum arabic, and if put on the market at all it should be as flour, to allow of admixtures to increase the viscosity. The conclusion is that the exploitation of "Boswellia serrata" should be a valuable commercial asset to India.

POTASH FROM KELP IN CALIFORNIA.

In the *Journal of Industrial and Engineering Chemistry* 1919, xi., 864, Messrs. J. W. Turrentine and Paul S. Shoaff describe the experimental plant of the United States Department of Agriculture at Summerland, California. Kelp is collected by boats of 100 to 150 tons capacity, provided with twin screws and driven by internal combustion engines. The extreme bow of the boat is provided with the harvesting apparatus, the kelp is cut by means of knives approximately 4 feet below the surface of the water, and is then carried to the deck by a conveyor; from 25 to 50 tons are harvested in an hour. The cargo is removed from the boat by an automatic fork, which delivers its load to the hopper of a chopper on the deck. The chopper cuts the kelp into lengths of approximately 6 feet, which are then moved to the storage bin of the plant by drag conveyors. The raw kelp is fed into a rotary drying kiln, where it meets a counter current of hot air, which enters the kiln at a temperature of 800° C. and leaves it at a temperature of 50° C. This preliminary drying is followed by a final drying in a similar kiln. The dried kelp is fed into the top of a retort, which is kept at a temperature of approximately 980° C. The charred mass is drawn off from a hopper at the bottom of a retort, cooled, ground, and lixiviated. The by-products are recovered. In the lixiviation use is made of leaching troughs, filter presses, and the principle of the counter current. The char is first extracted with a concentrated brine, while fresh hot water is used for its final extraction. The press coke of charcoal is extracted successively with hot hydrochloric acid and water; by proper extraction a product is obtained which is of

value as a decolorizing agent for certain organic liquids and aqueous solutions. The charcoal is then collected in a filter press and dried. After removal of sulphates, the brine from the leaching process is heated in a vacuum pan until a definite concentration is reached; it is then transferred to a vacuum crystallizer, where the potassium chloride deposits. The cooled brine is returned to the vacuum pan and further concentrated while sodium chloride separates. Each salt is washed, dried first in a centrifugal machine, then in a rotary counter-current, hot-air drier, and finally packed for market. The mother liquors are used until their content of iodine salts has become sufficiently great. They are then treated for the recovery of iodine as a by-product. The volatile by-products recovered from retorting include ammonia liquor, methyl alcohol, and an oily distillate from which have been obtained an oil which is of value in the concentration of ores by flotation, and a creosote which is highly toxic to bacteria and may be used as a wood preservative. Gas is also produced in the retort, and is used as fuel. By another process, the dried kelp is fed into one end of a rotary kiln while a flame from burning oil enters at the other end; the kiln is lined with fire-brick. Charcoal is produced and leaves the kiln at a low red heat. It may be quenched, ground, and leached to obtain the potash salts, or it may be permitted to burn to a loose, grey non-caking kelp ash with a potassium content equal to approximately 35 per cent. K_2O.—*The Chemical News.*

POTASH FROM KELP IN AUSTRALIA.

At the instigation of the Institute of Science and Industry analyses have been made of a number of specimens of kelp collected at various places off the Australian coast, with a view to determining their iodine and potash contents. On the average, the potash contents of the ash was shown to be about 14 per cent., although individual samples have yielded as high as 30 per cent. Before any expression of opinion could possibly be given as to the likelihood of a new commercial source of potash being developed, much further investigation would be necessary, and this would involve a great deal of expense. In the first place, there would need to be a thorough exploration of the fields of kelp, in order to determine their extent and also the suitability of their location for continuous harvesting. If collection were rendered intermittent on account of rough seas, stoppages would seriously tend, even where fields were dense, to make the recovery unprofitable. In California very large sums of money are being spent upon the experimental work in progress, and the results of the work are being followed with close interest by many countries.

"INDUSTRY AND SCIENCE."

Dr. A. W. Crossley, Director of the British Cotton Industry Research Association, in the course of an address at the third conference of the Research Association, pointed out that all great industrial advances had been the outcome of pure scientific research work. Rule

of thumb had carried many industries to extraordinary success in the past, but there came a time when rule of thumb failed to make advances, and when it became essential to know the scientific why and wherefore. One of the greatest chemical manufacturing magnates in the world declared in 1914—and the words were true to-day—that scientific research work carried out in the laboratory was the soul of industrial prosperity. In the past, it had been considered undignified for a professor to have something to do with trade, and many professors were bound by agreements which precluded them from any co-operation in trade work. A professor might not approach that awful thing known as a "patent" without himself and his institution becoming defiled. He was, nevertheless, intrusted with the duty of training students who would go into the industrial world as scientists. It appeared that, through the research associations, this misunderstanding could be rectified, and that the association could provide the link that had been missing in the past from the educational chain in this country.

AN INSTITUTE OF PHYSICS.

For some time past there has been a movement in Great Britain for the foundation of an Institute of Physics. The movement has been successful, and the institute has now been launched. It was felt that some action was necessary to strengthen the position of workers engaged in physics, and which also form a bond between the various societies interested. One of the principal aims of the new institute will be to secure recognition of the position and the value of the physicist. The success of the scheme was due to the co-operation, in the first instance, of the Faraday Society, the Optical Society, and the Physical Society of London, and the first Board is constituted from representatives appointed by the councils of these societies. It is hoped that, in the course of time, other societies will associate themselves with the institute. Members of the institute who are also members of more than one of the co-operating societies will obtain a reduction to the subscription of those societies. There will be three classes of members: Ordinary members, Associates (A. Inst. P.), and Fellows (F. Inst. P.). Only the two latter classes, membership of which will require full professional qualifications, will be corporate members. The institute has already received promises of support from leading physicists, and the initial expenses are covered by a guarantee fund amounting to over £1,200. The first President of the institute is Sir Richard Glazebrook, K.C.B., F.R.S.; Sir Robert Hadfield, Bart., F.R.S., is treasurer; and Prof. A. W. Porter, F.R.S., honorary secretary. The other members of the Board are—Dr. H. S. Allen; Inst. Commander T. Y. Baker, R.N.; Prof. F. J. Cheshire, C.B.E.; Dr. R. S. Clay; Mr. W. R. Cooper; Prof. W. H. Eccles; Major E. O. Henrici; Dr. C. H. Lees, F.R.S.; Mr. C. C. Paterson, O.B.E.; Major C. E. S. Phillips; Dr. E. H. Rayner; Mr. T. Smith; and Mr. R. S. Whipple. Mr. F. S. Spiers has been appointed secretary to the institute, and further particulars and forms of application for membership may be obtained from him at 10 Essex-street, Strand, W.C., 2.

SWISS AND GERMAN DYESTUFF PROFITS.

A report recently issued by the largest of the Swiss coal-tar colour firms, the Society for Chemical Industry, Basle, shows a net profit of £345,000, as against £248,000, and proposes a dividend of 15 per cent., as against 27½ per cent. last year. In addition a free bonus share is being allotted in respect of every three shares already held. The capital will then amount to £800,000. The balance-sheet of the Badische Anilin und Sodafabrik, Ludwigshafen, one of the large German concerns, shows a net profit of £1,350,000, as against £542,000 last year. It is proposed to pay a dividend of 18 per cent. as against 12 per cent. The capital is £3,625,000, as against £4,500,000, and it is proposed to raise it to £9,000,000. The report states that the works at Ludwigshafen and Oppau were closed from November, 1918, to June, 1919, owing to lack of coal, and since then only a small part of the plant has been working. Owing to the fall in the exchange value of the mark it has been possible to dispose of their stocks of dyestuffs to foreign buyers at prices which yielded handsome profits. Towards the close of the financial year the Ludwigshafen plant for colour making had again to be dropped, owing to the coal shortage, but it was possible to keep the acid plant working, and so maintain the production of the nitrogen factory. The balance-sheet issued by the chemical works formerly Weiler-ter-Meer, Uerdingen on the Rhine, shows a net profit of £129,000, as against £57,000 last year. A dividend of 12 per cent. is being paid, as against 10 per cent. The firm of Kalle and Co., Biebirch-on-Rhine, is paying 14 per cent., as against 7 per cent. last year. Profits are all estimated at the pre-war rate of exchange.

RESIGNATION OF PROFESSOR MASSON.

Owing to the alterations made in the Bill for the permanent establishment of the Institute of Science and Industry, which is now before the Federal Parliament, Professor Masson has resigned from the Advisory Council and from any participation in the activities of the Institute. The nature of the changes are explained in the leading article of this issue. In his letter of resignation addressed to the Prime Minister, Professor Masson pointed out that the Government did not before making these changes consult the Advisory Council, its Executive Committee, or himself, as its chairman (and also chairman of the original committee of conference); nor was the executive informed of them till after the Bill had passed its first reading. Professor Masson stated, moreover, that the effect of the changes would be to destroy the safeguards which were provided by the original scheme. "These, as you will remember," he wrote, "were accepted by yourself in January, 1916, after full discussion with my committee, and were subsequently approved by your Cabinet. They were designed to insure that the directorate would be strong on the scientific as well as on the business side, and thus be truly representative of both science and industry, and also that it would be constantly in touch, through the local Advisory Councils, with the leaders of science and of industry in all parts of the Commonwealth. If the Bill passes in its present form, the Institute will consist of one man, who can hardly be expected to combine in his own person all the essential qualifications, and who, if selected on account of his training in practical business, will not command the confidence and support of the scientific community."

Crop Losses.

(EWEN MACKINNON, B.A., B.Sc.)

Many of the present developments in agriculture are the direct outcome of the recent world-wide war. At first the greatest need of the combatants was ammunition; this gave place to a demand for men, and finally the most vital need was for food. This question of food supply was at first thought to be the means by which Germany might be brought to submission. Many optimists were of the opinion that

PLATE I.

Peach Leaf Curl, a fungous (*Exoascus*) disease that causes too much loss in Australia. It can be entirely prevented by proper spraying.

the Allies could bring this about not later than the winter of 1916. Statistics of food production and food consumption in Germany and her apparent dependence on outside supplies for amounts variously given from 15 to 30 per cent. of her requirements were relied upon by economists in coming to this conclusion. For a time the blockade

PLATE II.

Potatoes growing on the stem above ground, as the result of an attack in the roots by a fungus *Rhizoctonia*, a disease common in Australia and distributed by the seed tubers.

may have produced some food riots and other disturbances; but when a nation is fighting for its existence, food statistics, even though as accurate as the German ones are conceded to be, will be a poor guide as to what might happen. In addition to the successful food rationing of the nation, and the seizure of all food supplies in captured countries (*e.g.*, Roumania), the successful increase in the production of potatoes, the cultivation of much of the agricultural land that they gained, and the judicious killing of some of their stock (*e.g.*, pigs) after inquiry into the food that they required, in comparison with what they returned, must all be taken into consideration as deciding factors in maintaining the nation's food supply. The war commenced when the harvest of Central Europe had been garnered, and ample food supplies for at least a year were thus available. With the Allies food was also ample, but 1915 opened badly, as the Russian supplies were cut off in the first few months. The Allies began to realize that their own food supplies were likely to become a serious problem, and a great campaign was commenced, especially by Great Britain, to encourage greater production throughout the whole British Empire. The United States also advocated increased food production. In England many thousands of acres of pasture lands were put under food crops in the later period of the war.

Australia made a great effort in the year 1915-16, but since then drought has been a serious hindrance, and the average production has steadily fallen back to the old figure. In England and America production has steadily increased. In fact, after 1915-16, when the wheat area of the world was extended by more than 18,000,000 acres, the food problem became one of transport rather than one of quantity.

In addition to the obvious method of increasing the area under cultivation or also of changing the nature of the area, *e.g.*, replacing grass land by wheat or potatoes, and fibre crops by food crops, there are other methods which can be applied to the cultivation of existing areas, with the prospect of increasing production, without the additional cost of the preparation and cultivation of the added area. These include such methods as introducing improved varieties, and especially those resistant to disease; better seed selection and treatment; better cultivation, including rotations and manures (chemical fertilizers, cover crops, and animal manure); the reduction of loss by the better investigation and control of fungous, insect, and other diseases. The last method has been taken up, to some extent, in England, where an Imperial Bureau of Mycology has been formed; but it has remained for America to grapple seriously with the problem. There was already in existence the American Phytopathological Society, an influential body comprising the leading phytopathologists throughout the United States and Canada. At their ninth annual meeting on 1st January, 1918, this society created the War Emergency Board of American Plant Pathologists, which was "charged with the responsibility of stimulating and accelerating phytopathological work to the end that in this present world crisis the reduction of crop losses from disease should be made most effective as a factor in the increase of our food supply." It had to promote the co-operation of all the workers and to co-ordinate all the work undertaken in their efforts towards speedy

solution of the vital emergency problems. The methods adopted were as follows:—The United States was divided into six districts, and a Commission appointed to represent each, together with one from Canada and one from the United States Department of Agriculture. These representatives (8) constituted the War Emergency Board, which held meetings and arranged plans and a general system of projects, which were then submitted to representative meetings at each of the six centres.

All pathologists, botanists, experiment stations and agricultural representatives interested in plant pathology were invited. The problems of the district were fully discussed, the major projects formulated, and united action arranged. The attendance at these district conferences ranged from thirty to over fifty, and took three months to carry out. The War Board then held its third meeting to "take stock" of the progress, to digest and co-ordinate the results, and to perfect the programme of action for the rest of the year.

The National Research Council, recognising the importance of the Board's work, provided considerable support, which largely helped in the successful prosecution of the work.

One of the first projects carried out was the preparation of crop loss estimates. Even in the United States of America, with a well-developed Federal Agricultural Department and extensive State Experiment Stations, and University Agricultural Colleges in every State, the data for this work were lacking. Consideration of the results at once brings to the mind some conception of the enormous loss and waste that take place annually, practically unknown to the majority of the people, who have, on account of these losses, to pay higher prices for their food. No doubt there are serious losses and much preventable waste in other directions, but many have a way of asserting themselves that is not possible in crop production. Should a single sheep or a cow die, one becomes conscious of the fact if the animal be allowed to remain a few days where it died. But if a field of wheat be wiped out by rust, if acres of potatoes be blighted, and thousands of bushels of beans be destroyed by anthracnose, is the result heralded abroad with as much publicity as the death of one animal? If we had for our plant industry the same carefully prepared statistics as for our animal industry, and if the same relative attention were given to the investigation and control of plant diseases, much of this unrecorded, unheralded, and unrecognised loss could be prevented, with great advantage to the community. Let us turn to some of the statistics for support of these statements. The year 1917 was not one generally favorable for the development of fungous diseases. In the United States of America some of the losses were approximately as follows:—

Corn, loss 175,000,000 bushels (at 4s. a bushel) ..	£35,000,000
Oats, loss 154,000,000 bushels (at 3s. a bushel) ..	£23,000,000
Wheat, loss 64,440,000 bushels (at 5s. a bushel) ..	£16,000,000
Potatoes, loss 117,000,000 bushels (at 2s. 6d. a bushel)	£15,000,000
Barley, loss 12,000,000 bushels (at 3s. 6d. a bushel)..	£2,000,000
Loss on above crops for year 1917	£91,000,000

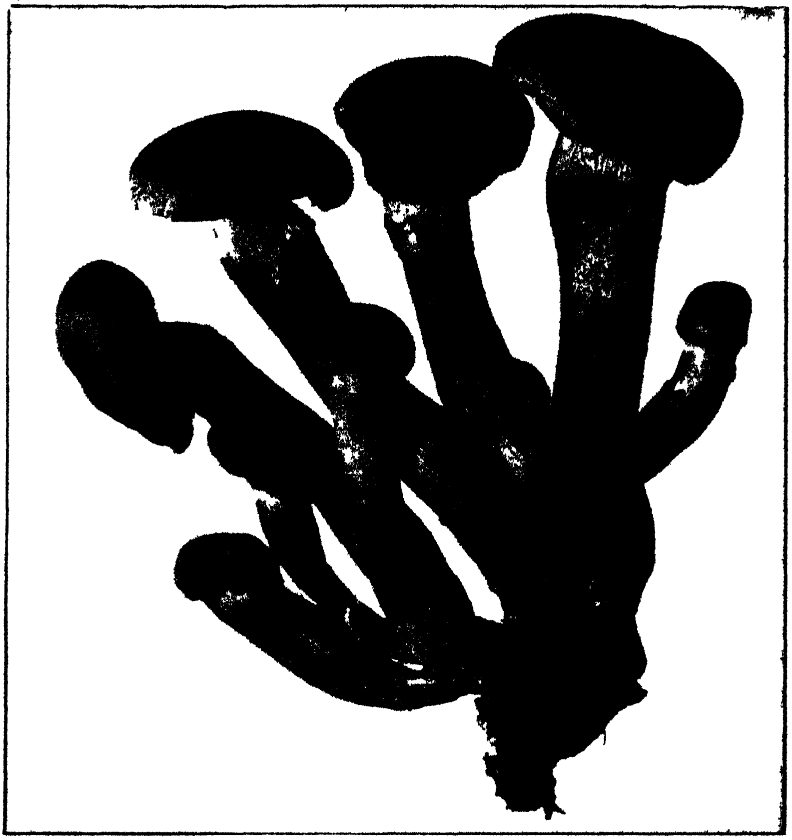


Plate III (A)

Plate (III B)

(A) An innocent looking fungus (*Armillaria*) above ground, but an insidious foe below the surface of the soil Attacks all orchard trees.
(B) Roots of a Peach tree killed by the fungus Investigation is required to find a suitable control.

In 1916 the loss of wheat from rust was 200,000,000 bushels, or more than the whole wheat production in Australia for the year 1916-17, and at 5s. a bushel equals £50,000,000. The damage caused by late (or Irish) blight to potatoes amounted to 25,000,000 bushels. If bunt and loose smut of wheat had been properly controlled by seed treatment, the United States of America could have supplied the Allies with an additional 33,000,000 bushels, valued at over £8,000,000.

PLATE IV.

A Banana disease known as Bunchy Top, which occurs in Australia, Fiji, and Ceylon. As far as known, it is due to unfavorable soil conditions which stunt the plant's growth, and prevent the formation of fruit.

Smuts destroyed over 108,000,000 bushels of corn (maize), or about twelve times the total maize production of Australia, and at 4s. a bushel equals £21,000,000. One serious maize smut that occurs in the United States of America is still excluded from our maize-producing areas.

The following general averages of annual losses were obtained in the American estimates:—Loss on all crops inquired into for the year 1917, 12.5 per cent., consisting of sweet potatoes, 32 per cent.; ordinary potatoes, 21 per cent.; cotton, 15 per cent.; beans, 12 per cent.; sugar beet, 12 per cent.; wheat, 9 per cent.; oats, 9 per cent.; barley, 6 per cent.; corn, 5 per cent.; rye, 4 per cent.

When climatic conditions are favorable for the development of fungi, epidemics often occur, and the losses are enormously increased. A few examples of these are—

Potato blight in Ireland (hence the name) in 1845 destroyed practically the whole crop, causing great famine. In New York State, in 1904, it caused £2,000,000 loss; in New Zealand, 1905, £200,000; and in New South Wales, 1909-10, the greater part of the crop. Peach leaf curl, in the United States of America, 1900, caused £500,000 loss. This disease is now entirely preventable, though it occurs largely throughout Australia, and its effects on the tree are cumulative.

Brown rot of the peach, in Georgia, in 1900, took half the crop (loss £100,000); similarly in Missouri, in 1910, the whole of the crop in all unsprayed orchards was lost. In New South Wales, in 1914, over 50 per cent. of the stone fruit crop suffered. The rust epidemic, in New South Wales, in 1916, took over one-third of the wheat crop.

Recently, by the importation of Australian wheat to the United States of America, two of our diseases, Flag Smut and Take All, which did not exist in America, were introduced, though the American authorities had been warned of the possibility. Over 6,250,000 bushels were imported through Californian ports, ground to flour, and sent to Europe, while the bran and by-products were retained in the country to feed stock. It has been stated that these two diseases in Australia destroy from 10 per cent. to 20 per cent. of the wheat crops in bad years. In Illinois and Indiana, where the American outbreaks occurred, serious damage resulted. In some cases 95 per cent. of the crop was destroyed. Whole fields have been ploughed up to stop the spread of the diseases. On 15th August, 1919, a quarantine regulation was issued, prohibiting the importation into the United States of America of wheat from Australia, India, and Japan, and of rice, wheat, oats, and barley from Italy, France, Germany, Belgium, Great Britain, Ireland, Brazil, and Australia, as Flag Smut occurs in the former on wheat only, and Take All occurs in the latter countries, and may affect the cereals mentioned.

Very energetic steps are being taken in addition to stamp out these two diseases. The Federal Horticultural Board, in co-operation with the two States, will burn all straw and stubble, will disinfect all grain, and prohibit the further growing of wheat in such districts.

Australia could adopt, with great advantage, many of the vigorous American methods of dealing with new infectious epidemics, quarantine restrictions (*e.g.*, treating all postal packages in steel cylinders, in which a vacuum can be first produced, and then the fumigating gas admitted), and phytopathological work generally.

CROP LOSSES.

The crop loss estimate was the first project undertaken by the War Emergency Board. Such an estimate is necessary before undertaking district projects, as it enables one to see what is the relative importance of the various diseases, to what extent they will afford opportunity for co-operative work, *i.e.*, whether they are local or general in distribution, and to what extent experiment or research is necessary in connexion with their control.

Although there is a Bureau of Crop Estimates in the United States of America, the necessary data were obtained from replies to many letters and circulars, and from consultations with many plant pathologists. The estimates were prepared for each State, and a preliminary set of figures for the staple crops for the whole of the United States of America was submitted to very careful consideration and revision before a final set was arrived at.

Our own statistics of cereals, fruit, potatoes, &c., are prepared by the statistician on various estimates submitted from numerous sources and from whatever returns are available, and are revised from time to time, and finally checked as accurately as possible by the results recorded. In the first place, however, the figures supplied are not the result of measurement, as a rule, and too many things are given under one heading. They are not sufficiently explicit, not adequate for the purposes required, nor available at a sufficiently early date to be of much value to plant pathologists. In preparing a census of diseases and crop losses assistance could be given by agricultural and fruit inspectors, secretaries of agricultural bureaux, experiment farm managers, and experimentalists, fruit-growers' and farmers' associations, &c., with the co-operation of the Agricultural Department of each State. At the same time useful information on many related questions could be collected in preparation for various projects that must ultimately be carried out under its guidance, and with the co-operation of the various State Agricultural Departments.

Some of the main lines of inquiry of these proposed surveys would be as follows:—

1. To record the distribution of diseases of plants and their annual prevalence in each section of the country.
2. To estimate the amount of loss suffered each year in order that the economic importance of the subject may be understood.
3. To discover the introduction into the country of new and, possibly, dangerous diseases, to the end that restriction measures may be advised.
4. To study epidemics of plant diseases in relation to weather, crop distribution, and other factors, and to obtain a better knowledge of the conditions governing the development, spread, and control of such outbreaks.
5. To gather data respecting the resistance and susceptibility of varieties to disease, for comparison of reports from different sections and correlation with climatological records.
6. To develop closer relations between phytopathologists, to build up mycological collections, to illustrate the geographical range of plant parasites, and to publish from time to time special articles or monographs on this subject.

For the present I have endeavoured to prepare the way for a more complete census, and to bring before those interested some idea of the great losses that take place annually in Australia through the destructive agency of plant diseases, excluding those caused by insects which are no doubt equally as destructive.

As the American estimate averages 12½ per cent., it is considered that 15 per cent. for Australia is a conservative estimate, as in such subjects as seed selection and seed treatment, the general use of fertilizers, spraying, dusting, and soil fumigation, and other methods of disease control, breeding for disease resistance, and the rapid transport of fruit, with the use of refrigeration, are more generally practised there than in Australia, and these must tend to reduce the annual losses.

With the addition, then, of farm crops (*e.g.*, lucerne, pumpkins, peanuts, cotton, flax, &c.) and vegetables (beans, peas, cabbage, cauliflowers, beet), we are justified in assuming £40,000,000 to be the net yield, after allowing for 15 per cent. as the average annual loss. Therefore, the gross yield is £47,000,000, and the loss (15 per cent.) on this is £7,000,000.

As the scheme is only an estimate, the method of deducting the percentage of loss from the individual yields given in the *Commonwealth Year-Book* has been adopted, though this is not strictly accurate, as shown above for the total yield. The statistician's figures are undoubtedly net yields and values, so that in the case of potatoes, *e.g.*, 347,000 tons, this represents only four-fifths of the gross total, which then becomes 434,000 tons, and 20 per cent. loss on this would be 86,800 tons, valued at over £400,000.

Crop Loss Estimate for the Commonwealth of Australia.

Crop. 1917–18.	Yield in Bushels.	Value.	Disease.	Per Cent. Loss Caused.	Quantity of Loss.	Value Lost.	Remarks.
Wheat ..	115,000,000, average 11.74 bushels per acre	£27,200,000, £2 15s. 8d. an acre, 5s. 9d. per bushel	Rust, Smuts, Bunt, Take All, Mildews, Septorias	12 to 15 per cent.	13,800,000 to 17,000,000 bushels; in a bad season up to 20,000,000	Approximate annual, £4,000,000 to £4,750,000	A Rust epidemic may take one-third of crop. A single disease, *e.g.*, Smut, or Bunt, or Take All, might cause 12 to 15 per cent. loss in a year. Take All probably takes 7 per cent. annually
Oats ..	10,387,000, average 18 bushels	£1,873,000, £3 an acre, 3s. 9d. per bushel	Smuts, Rusts ..	10 to 12 per cent.	1,000,000 bushels	£200,000 ..	U.S.A. loses 9 per cent. annually
Barley ..	4,000,000, average 19.5 bushels	£834,000, or £4 1s. 5d. per acre	Smuts, Helminthosporium	6 per cent. ..	240,000 bushels	£50,000 ..	U.S.A. loses 5.5 per cent.
Maize ..	8,843,000, average 26.4 bushels per acre	£1,902,000, £5 14s. 7d. an acre, 4s. 8d. per bushel	Ear Rots (Fusariums), Helminthosporium, Rusts	12 to 15 per cent.	1,000,000 to 1,500,000 bushels	£300,000 ..	In New South Wales Ear Rots and Helminthosporium produce an annual loss of about 15 per cent. The average annual loss is more nearly 20 per cent.
Potatoes	347,000 tons, average 2.66 tons per acre	£1,749,000, £12 16s. 9d. per acre	Early and Late Blights, Fusariums	20 per cent.	70,000 tons	£350,000 ..	Average annual U.S.A. loss for all potato diseases 21 per cent. In some years Irish Blight takes more than half of crop. Other fungi are numerous and serious
Fruit ..	.. ..	£4,340,000 ..	Ripe Rot, Brown Rot, Rusts, Leaf Spots, Bitter Pit, Spots (Black), Shotholes, Scabs	20 per cent.	.. ..	£870,000 or £750,000 to £1,000,000	This is a very moderate estimate, more nearly 25 per cent., *i.e.*, £1,000,000
	Total value ..	£37,898,000	Average Loss ..	13 to 15 per cent.	Estimated annual loss ..	£6,000,000	Average annual loss may be taken as approximately 15 per cent.

The Imperial Aspects of Chemical Science.*

By PROF. SIR WM. J. POPE, F.R.S.

When the student of the future is able to survey dispassionately the history of the nineteenth and the earlier part of the twentieth century he will, without doubt, insist strongly upon the very distinct way in which these two periods are differentiated from every preceding era. The vast expansion of the experimental sciences which took place around the opening of last century led to an entire change in the outlook of mankind upon the external world. From prehistoric times until the introduction of the locomotive, the steam-ship, and the electric telegraph, means of communication had remained practically stationary. The transport arrangements made by Cæsar for landing his legions in Britain were to all intents and purposes identical with those made, more than eighteen centuries later, when Wellington took his armies to the Continent to fight Napoleon; such minor differences as existed arose from the introduction of the firearm as a scientific weapon. The obstacle placed by geographical distance in the way of human inter-communication had preserved its magnitude unchanged from time immemorial; it has diminished progressively throughout the last century, and the past twenty years have seen it reduced to comparative unimportance by the advent of the aeroplane. It is safe to predict that before the middle of the twentieth century men and goods will be transportable between any two points on the earth's surface in less than twenty-four hours.

Some, at least, of the methods involved in this remarkable development of human powers of locomotion are easily understood by any one not possessed of the knowledge of a specialist. Man has acquired, by the invention of special appliances, the power of concentrating energy into small weight and compass, and using it for purposes of locomotion; the details may be obscure, but the general result—that if a man can control and handle mechanical power far greater than that exercised by his own muscles, he can achieve feats of movement and action quite beyond attainment by the naked savage—is quite incomprehensible. So soon, however, as we pass from the consideration of the purely mechanical to certain of the other great forces of nature, difficulties in exposition and comprehension seem to arise. It appears easy to understand the working of powerful mechanical appliances because their effects are but multiples of those produced by our own limbs; it seems difficult to the non-technical person to grasp why that intimate mixture of three such inert materials as sulphur, charcoal, and nitre, which we call gunpowder, should be capable of exploding with a loud detonation and with violently disruptive effects. Nature has given us some intuitive power of understanding purely mechanical effects, those being needed in our

* A Lecture delivered before the Royal Dublin Society on 4th February, 1920.

ordinary actions, but has found no need for providing us with any faculty for appreciating without artificial training the more subtle chemical activities which maintain our bodies in life. From the purely human point of view our natural disability to understand chemical changes introduces a difficulty which has been existent since prehistoric times.

The progress which has been made in medicine and surgery may be quoted as an example of the operation of a chemical factor in the occurrences of human life which will seem to most people more subtle in its incidence and elucidation than any application of merely mechanical agencies. In mediæval times a man was regarded as aged at fifty; the average expectation of life was certainly less than one-half, and probably less than one-third, what it is at present. A larger proportion of the newly-born of this century survive to the age of seventy than attained the age of forty at the period of the English Reformation; life in earlier days was a nightmare haunted by apprehension of mysterious pestilences which killed at a few hours' notice and by minor ailments and slight wounds which generally proved fatal. The scientific use of anæsthetics, introduced by Simpson, the scientific application of antiseptics, introduced by Lister, and the development of the science of preventive medicine, based upon the work of such men as Jenner and Pasteur, have changed all this. These new branches of science were products of the nineteenth century, and no student can doubt that they are still in their early infancy; although they embody scientific principles they have in the main progressed to a large extent empirically. In the near future these branches of human knowledge will receive more rigid scientific treatment than they enjoyed in the past, and whilst the average expectation of life has been doubled during the initiation of the scientific era of medicine, it is safe to premise that within another quite short period it will be doubled again. Until a few hundred years ago a man was middle-aged at twenty-five, to-day he is middle-aged at fifty; within the next fifty years he will attain middle-age towards one hundred.

Whilst preventive medicine has put into man's hands a powerful instrument for the alleviation, or, perhaps, rather the postponement, of suffering, it cannot be denied that the subject has another aspect. During all time previous to the scientific development of preventive medicine a natural limit was imposed upon the size of armies; the maximum was a few hundred thousands. Every attempt to exceed a figure based on such a unit was frustrated by the onslaught of a pestilence which speedily reduced the numbers to the normal standard recognised alike by Hannibal and Wellington. Without the aid of preventive medicine any army numbering one or two million men would, within two months, be reduced by pestilence and disease to the pre-scientific standard measured by hundreds of thousands. Preventive medicine has been the enabling cause for the stable existence of armies numbered by millions of men, and has been the prime cause of the death of innumerable hosts of combatants and non-combatants—at a modest computation, fifty millions—by battle, famine, and disease over the whole surface of the globe. The potentialities for good inherent in every great branch of scientific progress are invariably reflected in potentialities for destruction.

It is to be anticipated that future progress, both in preventive and curative medicine, will be based necessarily on minute investigation of a purely chemical kind. All the diverse branches of modern medicine, whether curative or preventive, are rapidly changing and reappearing as highly specialized and very intricate sections of organic chemistry. The attack upon syphilis, which until recently was one of the several diseases generally regarded as practically hopeless, consists in introducing an arsenical compound into the blood-stream for the purpose of eradicating the organism by simple chemical poisoning, before killing the patient. The modern treatment of diphtheria, which has reduced this previously very fatal malady to comparative triviality, depends upon the application of the well-known doctrine of chemical equilibrium, in which a chemical reaction, slowly progressing, is inhibited by introducing into the reacting system a considerable quantity of one of the products of the reaction. Methods of treatment, based entirely upon a sound appreciation of chemical science, have gradually and furtively taken their place in clinical work; they provide a foundation for further progress on the same lines, and we may look forward to a time when all the great scourges of the human race—influenza, phthisis, cancer, and syphilis—will have lost their horrors. From an Imperial point of view, it is impossible to overrate the importance attaching to the intensive cultivation of this branch of chemical science in an Empire such as ours, which has to administer vast tropical colonies in which malaria, sleeping sickness, cholera, and a host of other indigenous diseases have in the past impeded colonization.

The pursuit of new scientific knowledge labours under one very grave disadvantage. It is impossible to select for study any branch of experimental science without being convinced that, no matter how remote from human interest the subject may be, sooner or later the results obtained will find practical application. The discovery of the radio-active element, radium—with all its potent consequences in revolutionizing our fundamental conceptions of matter and energy—a discovery which began with Crookes and Becquerel, was brought to fruition by Madame Curie, and has yielded most portentous results at the hands of Thomson and Rutherford—has involved us more rapidly and more deeply in the subtle details of the constitution of the Universe than any other made throughout the whole history of science; yet many people already carry watches which can be read in the dark with the aid of figuring done in radium paint. The element helium was discovered by Lockyer in 1868 as existing in the outer atmosphere of the sun with the aid of the spectroscope; the statement by Lockyer that he had discovered this light gaseous element in the sun's chromosphere aroused merely academic interest, and until a few years ago helium had not been found on our earth. An inquiry initiated by the British Admiralty showed that large quantities of helium are obtainable on the earth's surface, and, had the war continued for another six months, our uninflammable airships, filled with helium, would have been dropping bombs on Berlin. Many instances similar to these may be quoted to show that every great advance in experimental science made in the past has rendered unexpected but nevertheless invaluable service in connexion with practical affairs; all experimental scientific discovery, in fact, savours of the shop, and sooner or later becomes an adjunct to

some object of commercial activity. The superiority of classical or humanistic over scientific studies, as instruments for the training of the intellect, lies in the freedom of the former from this taint.

One of the most striking of the many Imperial aspects of chemical science is presented by the great question of the provision of nitrogen compounds. Every kind of living matter requires for its sustenance supplies of compounds which contain the element nitrogen in such a condition as to be assimilable by the living material. Even the most highly developed forms of vegetable life are capable of absorbing nitrogen from the simple types of combination of the element as ammonia, salts of nitric acid, and urea. The higher animals are incapable of utilizing nitrogen presented in such simple combinations as these; they require nitrogenous food in the form of such complex compounds as the proteins or albumenoids which are present in other animals or in vegetable materials. The nitrogen thus absorbed by the animal leaves the living body by excretionary or putrefactive processes to reappear ultimately in the dead form of ammonia, nitrates, or urea. A kind of cyclic process is thus apparent in nature. The last-named simple forms of nitrogen compounds are extracted from the soil by vegetable life and elaborated into the complex nitrogenous protein suitable for assimilation by the animal; the animal returns this absorbed nitrogen to the soil by excretion or putrefaction as simple nitrogen compounds which are once more available for the sustenance of vegetable life. The animal may, of course, serve as food for another animal such as man, but this step is not an essential one. The sheep, which we eat in the form of mutton, merely acts as a kind of "middle man," passing the highly complex nitrogen compounds on from the vegetable factory to us; the devotees of vegetarianism claim that in serving this function the sheep behaves as a shameless profiteer.

The contemplation of this nitrogen cycle makes it clear that, mainly in view of the enormous loss of excreted nitrogen, continuous supplies of simple nitrogen compounds must be provided for the sustenance and propagation of the vast quantities of vegetable matter which all animals need to keep them alive. It is thus necessary to supplement the supplies of ordinary farmyard manure, which are useful only as providing nitrogenous compounds to vegetation, by other nitrogen compounds to replace loss and to meet the constantly increasing demands of a growing world population.

Previous to the war the supplies of nitrogenous compounds thus called for were drawn in the main from the huge deposits of nitrates which occur as Chili saltpetre, and which represent the accumulation of ages of excretory and putrefactive products of bird life in South America. During the few years before the war an average of some 20,000 tons per annum of combined nitrogen were imported into Great Britain in the form of Chili saltpetre; approximately the same amount of combined nitrogen was reserved for home use annually from the ammonium salts produced during the production of illuminating gas from coal. It is clear, however, that the needs of the future will be enormously greater than those indicated by these figures. The late Sir William Crookes called attention to this in 1898, and pointed out that only by largely increased application of nitrogenous manures to the soil

could we expect to raise the production of wheat per acre to the amount soon to be demanded for the feeding of the world's population; he insisted that the securing of large supplies of simple nitrogenous products was purely a problem for the chemist, and that the question was clamant in view of the limited available supplies of Chili saltpetre.

Having made clear the necessity for increased supplies of simple nitrogen compounds, another side of the whole large subject may be reviewed. Atmospheric air is a mixture of four volumes of nitrogen to each one of oxygen; the nitrogen which is thus available in limitless quantity is in an uncombined state, and, for all practical purposes, practically unassimilable by vegetable life. The task before the chemist is indicated as that of devising processes for the conversion of this gaseous nitrogen into the simple combined form in which it exists in ammonia, nitrates, or urea, so as to render atmospheric nitrogen available for manurial purposes. This task has been accomplished, and the intense needs of the last five years have led to this result of pure scientific investigation being translated into large-scale technical practice; the vast quantities of simple nitrogen compounds required by Germany during these years of war have been obtained almost entirely from atmospheric nitrogen by chemical methods.

In 1785 Cavendish showed that nitrogen and oxygen could be caused to combine by the passage of an electric spark; this observation has been utilized to bring about the conversion of atmospheric nitrogen into nitric acid on a large scale by heating air in the electric arc. In 1864 Deville observed that ammonia could be produced by the action of the electric spark on a mixture of nitrogen and hydrogen. A technical method for the production of ammonia by heating a mixture of nitrogen and hydrogen under pressure and in contact with some material which hastens combination has been elaborated as the so-called Haber process; this process has been established in Germany on a scale capable of producing 650 tons of ammonia per day. Later, Moissan showed that an intimate mixture of carbon and lime, when heated by the electric arc, gives the now familiar substance, calcium carbide; it was then found that when calcium carbide is heated in a stream of nitrogen, combination occurs to yield a product, calcium cyanamide, which is converted by water into urea and ammonium salts. This series of operations is now in production on an industrial scale.

It is interesting to notice that the scientific observations upon which the three above-mentioned technical methods for the utilization of atmospheric nitrogen are based were made in England and in France, but that the technical processes themselves were first worked out and installed by Germany. It is further of importance to note that such simple nitrogen compounds as nitric acid and ammonia are prime essentials in the manufacture of military explosives, that the chief sources of these nitrogen compounds were until quite recently found in Chili saltpetre, and that the import of Chili saltpetre into Central Europe would be at once stopped by war; also that Germany did not embark upon a world war until the several methods for converting atmospheric nitrogen into the nitric acid required for the manufacture of great supplies of both propellant and shattering explosives had been worked out upon such a scale as rendered Central Europe independent of imported Chili saltpetre as a raw material.

Estimates, which certainly lean towards the conservative side, of the requirements of combined nitrogen for various purposes in the United Kingdom are given in the recently published report of the Nitrogen Products Committee, a document worthy of serious study by every one interested in the future of our Empire. Immediately prior to the war, agriculture in the United Kingdom absorbed an annual average of 25,000 tons of nitrogen in the form of artificial fertilizers; the present demand of agriculture in the United Kingdom is estimated as 60,000 tons per annum, and the possible demand in the near future as 100,000 tons per annum of combined nitrogen. Small deficits in the supply of the difference between 25,000 and 100,000 tons per annum of combined nitrogen will be met at the cost of our manufacturing and export trades; a large deficit will be met by starvation. The only method of averting a species of nitrogen bankruptcy of the Empire lies in the installation on a huge scale of the several types of process for utilizing atmospheric nitrogen.

Equally important from the Imperial point of view is the organized large-scale exploitation of the limitless resources of our colonies in the shape of raw materials for the manufacture of edible fats and oils. The fatty materials which we consume are utilized in the animal economy mainly for the provision of the energy which we throw out as heat and in muscular effort. It is curious to reflect that the actual material consumed acts merely as a store of the energy which it brings with it in the form available for animal use, and that the margarine produced by chemical methods from palm kernel or cocoanut oil, which we eat, merely serves as a carrier to our bodies of heat energy projected from the sun into one or other of our tropical colonies. Great as has been the development of those scientific industries which involve the conversion of vegetable oils into common foods by chemical methods during the last five years, much still remains to be done to utilize these tropical products.

We may now pass from this brief and inadequate discussion of the great Imperial aspects of chemistry which concern the maintenance of connexion between body and soul to the consideration of several other large chemical problems which our Empire has to solve.

It is well known that the industry concerned with the manufacture of the so-called coal-tar colours was founded upon the purely scientific chemical work of the late Sir William Perkin, and that the industry, started in the United Kingdom, soon languished with us and became one of the great and most profitable of German manufactures. Previous to the war we imported some £2,000,000 worth per annum of these dyestuffs from Germany, and the stoppage of this importation paralyzed our textile industries, which represents financial interests a hundred times as great. The early coal-tar dyes were brilliant but evanescent, and in point of fastness against light and washing fell far behind the few natural dyestuffs formerly in use; in this they probably but followed the fashion, for the demand came for light fabrics of gaudy colours capable of withstanding much less rough usage than the more substantial heavy cloths which our forefathers affected. The progress of chemical science led, however, to the discovery of more stable coal-tar dyes, and at the present time a variety of such substances extraordinarily resistant to change is available; some of the artificial

vat-dyes now manufactured are so inert towards the agencies which promote decay that they persist unchanged in shade even after the fabric carrying them has rotted away.

Fewer industries than that of coal-tar colour manufacture reveal more clearly the necessity for continual chemical investigation of a highly original order for the purpose of securing such developments as will best serve the incessant demand for improvement; like all chemical industries it depends for progress upon the intimate association of advance both in the science of chemistry and in the art of engineering, but this association of very diverse factors is less evident in most other large industries. The national importance of the synthetic dye industry has at length been brought home to our administrators, and Government support is now being extended to attempts, strenuous but tardy, to establish manufacture and invention on a scale commensurate with the needs of the Empire. The facility with which we have allowed German enterprise and industry to develop the artificial colour industry is surprising when we reflect that our colonies were at one time producers of the main bulk of the world's indigo supply; we allowed synthetic German indigo to oust British-grown natural indigo from the market absolutely without any attempt at competition from our colonial growers. Natural indigo has qualities as a dyestuff, due to its content of other and allied colouring matters, which render it in many ways superior to the pure synthetic material; it is in the highest degree probable that the scientific cultivation of the indigo plant, the scientific improvement of the archaic methods still in use for extracting the dye from the plant, and the scientific standardization of the natural product, would have effectually prevented synthetic indigo from gaining a remunerative market. Much valuable work has been done recently by Armstrong and Davis on the improvement of the cultivation and extraction of natural indigo. A very similar problem arose when economic reasons led to the need for extending the beet-sugar industry in competition with cane-sugar; seventy years ago the German manufacturers separated from the beet about 5 per cent. by weight of sugar; by scientific cultivation and scientific extraction they succeeded in separating from the beet more than 20 per cent. of its weight of sugar. If the yield of indigo from the plant could be similarly increased fourfold synthetic indigo would disappear from the market.

Innumerable other instances might be quoted to show that neglect of the Imperial aspects of certain great branches of chemical science has led us to the brink of disaster. For high-class pharmaceutical products, for glass apparatus such as chemical glass and optical appliances, for many essential metallic elements and alloys, and for other raw materials and final merchantable articles, all needing in their manufacture the application of perfected chemical methods, we have been content to rely on continental industry and foresight; very often, indeed, we have neglected natural sources which occur solely in certain parts of the British Empire and have allowed the German manufacturer to acquire the monopoly of their exploitation.

The dangers which result from complacency such as this may, perhaps, not be immediately obvious in times of peace, but the establishment of a state of war renders them imminent. Previous to the war

we were content to allow ten-elevenths of the world's demand for quinine to be produced in the island of Java; this material can be easily grown in several of our colonies. A large army suffers more loss from a shortage of quinine than from military operations. Should war catch us again without a reserve of a hundred tons of quinine actually among our military stores it should be regarded as criminal neglect. Similarly, our Empire has been content to draw most of its bromine from Germany; since bromine and bromides are necessary in medicine and in manufactures, the stoppage of imports led to considerable embarrassment. We can probably produce bromine more cheaply than Germany from the residues left in the production of salt from sea-water on the Indian coasts.

It must not be concluded that reflections such as these upon our past policy are of the nature of mere carping criticism. We have all received a very intensive education since the autumn of 1914; there is no merit in being wise after the event, but it is very essential that the lessons administered should profit us in the future. A consistent disregard of the Imperial aspects of chemical science previous to the war cost us hundreds of thousands of valuable lives during the war, and has post-war consequences which will influence our general prosperity adversely for some indefinite period yet to come.

It is noteworthy that the chemical works in Germany, the creation of the last fifty years, are capable of providing between them a considerable proportion of the world's requirements of chemical products of every kind, from the most inexpensive chemical substances right through a long series to the most costly, because the most difficult to manufacture, of the fine chemicals possessing any technical importance. Furthermore, the German chemical firms are all affiliated under one great central control, the object of which is to protect and advance the collective technical chemical interests of the nation. The United Kingdom has always been the seat of a flourishing chemical industry, which, however, only embraces certain sections of technical chemistry; many of our great chemical firms are at least as efficient as any on the continent, but, whilst our manufacturing industry has specialized upon more or less isolated patches of the great subject of chemical technology, we have been content to rely upon the German works for many expensive, but absolutely essential, chemical products. Further, the British chemical works have not co-operated in the establishment of a comprehensive organization for mutual protection; some may question whether such a union is in the interests of the nation, but the important point for the moment is that we have had no such co-operative system of working.

With these essential differences between German and British practice in mind, the immediate effect of a declaration of war can be realized. In Germany, mobilization meant the cessation of peace production and the concentration of effort on war production under the auspices of a central control well acquainted with the potentialities of each component factory; the type of organization existing lent itself to rapid and efficient production on a war footing. The autumn of 1914 found Great Britain with a chemical industry which had never produced a large number of chemical materials needed for military consumption

and with no organization which could bring all the different works into co-operative production upon the new basis; in fact, no single authority, whether an individual or a corporate body, existed who had more than a vague knowledge of the potentialities for production of the chemical works of the United Kingdom. The utmost confusion prevailed for a lengthy period, and was only slowly and incompletely dispersed by the intense labours of the newly established Ministry of Munitions.

The task of working up the Explosives Department of the Ministry, which was allotted to Lord Moulton, involved the manufacture of some 2,000 tons per week of propellant explosives, chiefly cordite, 1,000 tons per week of picric acid, 2,500 tons of T.N.T. per week, and 3,000 tons per week of ammonium nitrate, together with enormous quantities of essential auxiliaries, such as nitric and sulphuric acids, alcohol, and acetone. The scale of production attained by this Department constitutes one of the great achievements of the war; it is a remarkable tribute to the power of co-ordination exerted by its chief and to the enthusiasm with which our great chemical firms and the departmental staff of chemists and engineers co-operated in its establishment. It is true that many mistakes were made, but it is equally true that our enemies, in spite of their already existing organization and powers of production, fell into more numerous and more disastrous errors.

In one respect the chemical manufactories of Central Europe still retain an important advantage over those of the United Kingdom. The German works have been greatly extended during the war, but owing to the pre-existence of a highly efficient organization it has been possible to carry out the developments called for by increasing military demands in such a manner that the whole can be effectively utilized on demobilization for a much larger peace production. The major portion of the new works established in Great Britain were of necessity designed purely to meet war requirements, and are now to all intents and purposes useless. Whilst many of these works are now entirely derelict the corresponding German works are ready to meet far greater calls on their peace production of important chemical substances; in this respect Germany leaves the war better equipped as a manufacturing competitor than when she entered it.

The maintenance of a kind of census upon the capacities of production of the chemical works of the country, and of a sort of control to insure that the country can command under any prevailing external conditions the needed quantities and varieties of explosives for military use, is essential. This is an Imperial aspect of chemical science neglect of which will not be susceptible to remedy in the future as it has been in the past. The Empire requires to maintain intact its large heavy chemical industry, the manufacture of alkalies and their compounds, and of common acids, and all those chemical industries concerned with metallurgical products and compounds of the metals, and to insure that it is capable of supplying home, colonial, and certain foreign needs on a competitive basis under peace conditions, and all probable home needs in time of war. A flourishing fine chemical industry capable of producing synthetic dyes, pharmaceutical and photographic requisites, and large numbers of other organic compounds for which the demand is small but imperative, is also essential to the well-being of the Empire in either peace or war.

Every one is aware that the German and the smaller British coal-tar factories have played a large part in the provision of high explosives during the last few years. In any future war they will undoubtedly play a much larger part in view of the introduction of poisonous materials as a new military weapon. The use of poisonous substances in warfare is forbidden by the Hague Convention, but notwithstanding this the Germans launched an attack on the Allies with the poisonous gas, chlorine, on 22nd April, 1915, and it soon became clear that this operation was but the precursor to an elaborate programme for the extensive use of such materials. This action was greeted with universal horror, but the disgust expressed must be supposed directed not against the use of poisonous gases but against their use in the face of a covenant to the effect that they should not be used.

Apart from this vital point there seems little legitimate reason why poisonous materials should not be used in warfare; it is no less noble and chivalrous an action to kill an individual one never meets or sees by a whiff of poison gas or to leave him to die miserably from lung trouble caused by mustard gas than it is to tear his intestines to pieces by high explosive shell fired at a range of 20 miles. Every advance in military science has aroused a storm of execration; the use of large mechanically actuated catapults, which were introduced early in the twelfth century, against Christian troops, was forbidden by the second Lateran Council, under pain of excommunication.

Over 30 per cent. of all the casualties suffered by the American armies in Europe were due to chemical warfare; this preponderating effect of one arm, produced so short a time after its introduction, added to the heavy and costly equipment required for protection against gas, makes it certain that chemical warfare will become one of the main factors in future military struggles between civilized nations. The whole subject has been developed hurriedly on an emergency basis, and will be necessarily perfected to such a degree during the coming years of peace as will render the effects of chemical warfare catastrophic to the less well prepared of two adversaries.

The provision of the offensive and defensive needs of chemical warfare constitutes an Imperial aspect of chemical science upon which our whole future existence as an Empire may depend. The investigation of the possibilities of those needs calls, in the first place, for chemical research of a high order of excellence; the provision of the needs can only be met by the establishment of a large and flourishing fine chemical industry within the United Kingdom.

It will be remarked that I have laid stress in this lecture mainly upon the achievements of chemical technology, and have dwelt upon the necessity for intensive development in our islands of a branch of human activity which has been neglected to such an extent as constitutes an Imperial danger. This must be considered, however, in conjunction with the undoubted fact that all progress in chemical technology originates in scientific discovery and from research which, in the majority of cases, is undertaken with no eye to its future use in manufacture. The history of science abounds in illustrations of this principle. The purely scientific discovery of benzene in oil-gas by Faraday formed the foundation of the greater part of the fine chemical industry;

the pioneer scientific work of Faraday, Andrews, and Dewar on the liquefaction of gases, and of Cavendish and Deville on the combination of nitrogen with oxygen and hydrogen, laid the foundation of the great industries for the utilization of atmospheric nitrogen. Pure scientific investigation is carried out for the purpose of increasing our knowledge and enlarging our conception of the universe; its technical applications are all that we have to depend upon in the now necessary task of increasing production whilst simultaneously diminishing the burden of manual toil. The stimulation of purely scientific studies must thus be the prime care of any one interested in the Imperial aspects of chemical science; the encouragement of scientific research in our Universities and Colleges calls for much greater expenditure of thought, effort, and money in the future than in the past on the part of all who have at heart the welfare of our Empire.

It is stated in *Nature* that botanists in Great Britain have been considering the practicability of holding an Imperial Botanical Congress in London, at which botanists from the overseas Dominions might meet their colleagues at Home for the discussion of matters of common interest. Many subjects are ripe for discussion, such as the methods of training botanists for service abroad, the relations between the pure science and its applications, and between the botanists and the commercial men interested in industries in which botanical knowledge should play an important part, more helpful co-operation between the Home and the overseas botanist, botanical surveys of overseas Dominions, and others. For the present, it has been decided that it would be inadvisable to hold the congress during the present year.

The British Department of Scientific and Industrial Research announces the formation of the Scottish Shale Oil Scientific and Industrial Research Association, which has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The Association may be approached through Mr. W. Fraser, C.B.E., Scottish Oils Limited, 135 Buchanan-street, Glasgow.

The Commonwealth Serum Laboratories,

Royal Park, Melbourne.

By W. J. PENFOLD, M.B., B.Hy.

Introduction.

The outbreak of war found Australia very largely dependent for vaccines, sera, and other bacteriological products upon importations from other parts of the world.

In 1913, the value of these products imported into the Commonwealth amounted to £15,306, while in the first year of the war only £8,406 worth were imported. This decrease in importations was, perhaps, partly due to the shortage in shipping facilities during the year 1914. The principal cause, however, was probably the fact that the Serum Institutes in the rest of the world were required to make large quantities of tetanus anti-toxin to supply the needs of the Allied Armies.

The shortage of diphtheria anti-toxin became so acute that a deputation representing the Victorian Hospitals Supplies Board, and headed by Canon Hughes, waited on the Minister for Trade and Customs, to urge upon him the desirability of Australia undertaking the preparation of therapeutic sera as a national work.

As a consequence of this deputation, steps were taken to found serum laboratories. The Minister requested Dr. Cumpston, the Director of Quarantine, to formulate a scheme for their foundation, and the scheme propounded by him was adopted.

Advertisements were inserted in the Australian and the British medical press, inviting applications for the position of Director of the proposed laboratories, with the result that the writer was appointed.

In order that the Commonwealth Serum Laboratories might be built on the most modern lines, and equipped with the latest appliances, and, further, in order that their technical work might be up to date, the writer was commissioned to visit laboratories in England, France, and America, with these ends in view.

The benefits derived from these visits were of great assistance in the establishment of the Commonwealth Serum Laboratories.

Initial Policy.—The initial policy of the Commonwealth was to provide sera, vaccines, and diagnostic agents for use in Australia. No provision was made for research. Neither was any hospital attached to the laboratories in which their products could be clinically tested, so that they were to be entirely dependent for clinical reports upon private practitioners and hospitals.

No provision was made for any teaching functions being exercised by the laboratories, though this was modified later to allow of the younger members of the Commonwealth Quarantine Service attending for a short course in bacteriological diagnosis.

It is evident, therefore, that the scope of the laboratories is very distinctly limited, and that without considerable development they cannot take that place in the medical life of the Commonwealth which many members of the medical profession in Australia feel that they ought to take.

Selection of Site.—In the establishment of the laboratories the first consideration was the selection of a suitable site. Various ones were inspected, but no difficulty was experienced in deciding upon the one now occupied.

The site of the laboratories at Royal Park has many advantages over others which were suggested. It has an area of twenty-five acres; it is well placed for the distribution of commercial products, being within easy distance of the city of Melbourne; it is close to the University, and in fine, open country.

General Construction.—With two exceptions, all the laboratories are concentrated within one building. This plan was less expensive than the building of various detached laboratories, and was adopted on account of the financial stringency consequent upon the war.

The exceptions referred to are the Plague Laboratory and the Jennerian Lymph Laboratory. The latter building was originally the property of the State of Victoria. It was taken over from that State by the Commonwealth when the latter was founded.

At the present time, therefore, there are three separate laboratory buildings on the area—two small ones, engaged in plague and Jennerian lymph work respectively, and one large one, in which all the other laboratory functions are discharged.

The main building consists of a central block and a south wing.

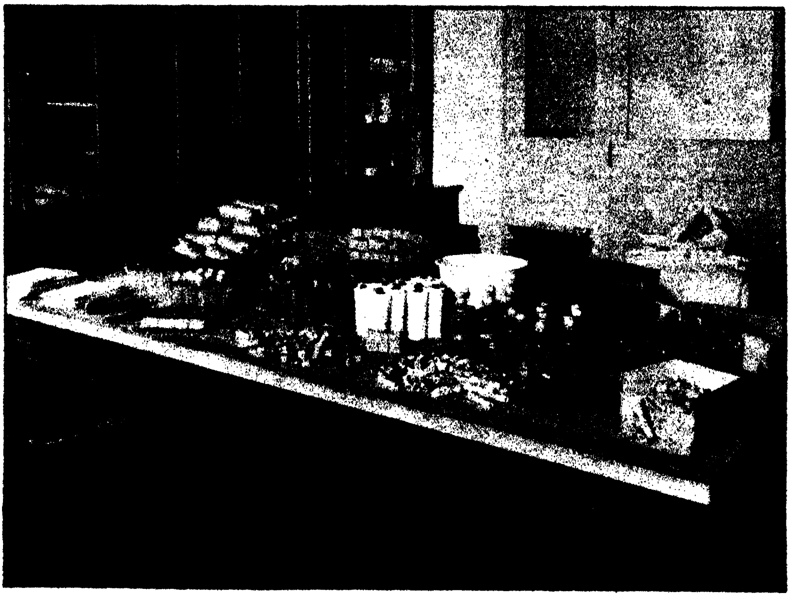
MAIN BUILDING.

Central Block.—On the ground floor of the central block are found the commercial offices of the laboratories, the Medium Department, and the packing room.

On the first floor are the library, the Director's office, the Director's laboratory, the diagnosis laboratory, and a small room where the ampoules, as received from Japan, are cleaned, dry-air sterilized, and stored until required in the bottling room.

On the second floor a large lecture hall is situated. Here also are a small kitchen and tea rooms, in which the staff are provided with lunch and tea, there being no restaurants within reasonable distance.

South Wing.—The ground floor of the south wing is occupied by the Serum Department, and the first floor by the Vaccine, Tuberculin, and Bio-chemical Departments.



PACKING ROOM.

A basement under the south wing contains an engine-room and stores, three of which are refrigerated, and kept at temperatures of 8 deg., 2 deg., and 9 deg. C. respectively.

The laboratories would be helpfully extended by the building of a north wing; should they develop as is anticipated this will be built at an early date. This wing might be devoted to the making of products used in veterinary medicine, and also, if possible, to medical research.

The Various Laboratories and their Functions.

Medium Department.—The Medium Department occupies four laboratories and two annexes on the ground floor of the central block.

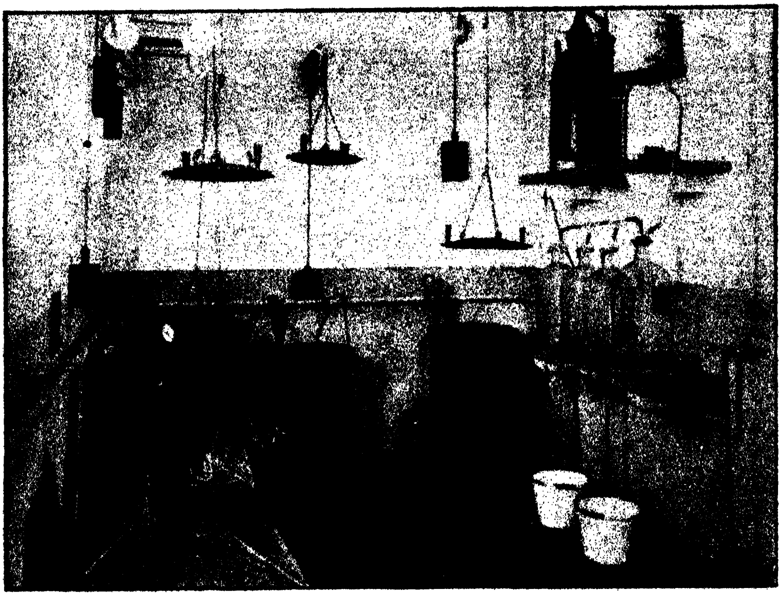
Two of the laboratories are used for the production of media, and two for the preparation and sterilization of glassware.

The two annexes contain the Department's sterilizing apparatus, consisting of a large autoclave, five smaller autoclaves, and three steamers. The large autoclave is capable of supplying about 100-120 litres of sterile material per day.

As the temperature in the annexes is frequently high, no workers are expected to work therein.

Media from this Department are distributed to all the other Departments of the laboratories.

Serum Department.—In the Serum Department there are three main laboratories, a large incubating room, a cool, dark cellar, a bottling room, an apparatus room, and the Technical Assistant's room.



STERILIZING ANNEXE.

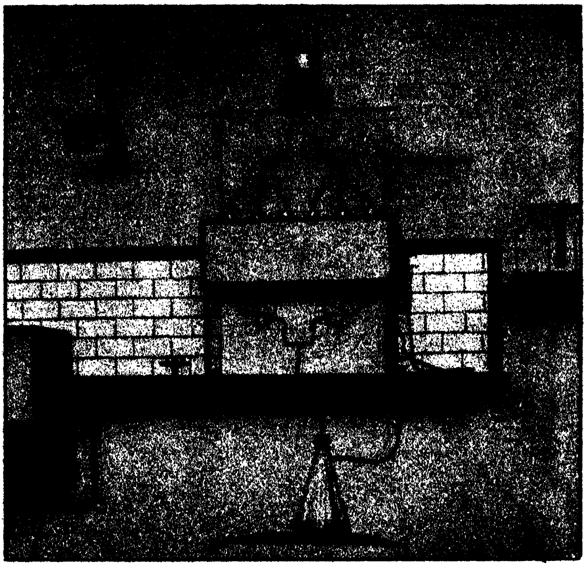
Two of the laboratories are used in the production of diphtheria toxin. In one, the broth required for the growth of the cultures is made, while in the other the broth is inoculated with the organism. After the cultures have grown for nine days in the incubating room, they are returned to this laboratory for microscopic examination to prove their freedom from contamination and for filtration. Toluol is added to the filtrate as a preservative. The toxin is then placed in the cellar to mature.

In another laboratory, the blood, as received from the stables, stands for from two to twenty-four hours to allow the red cells to sediment. At the conclusion of this period the supernatant plasma is syphoned off into Winchester quarts, and then placed in cool storage (8° C.). When this plasma is required for the production of serum, it is taken from the cool store and clotted by the addition of lime. The jars used for this purpose are similar to those in use at the Pasteur Institute, Paris.

The serum expressed from the clotted plasma is filtered through Lipscombe and Pasteur-Chamberland filters, in the filtration laboratory. It is then ready for issue.

Much of the plasma which is placed in cool storage is concentrated, and in this case the plasma is not clotted, but the pseudo-globulin fraction is separated from the other fractions of the protein of the serum in the Bio-chemical Laboratory.

The bottling room is fitted with hermetically-sealed windows, and is supplied with filtered sterile air. Products being bottled are, therefore, not endangered by the presence in the atmosphere of any contaminated dust.



FILTERING APPARATUS (SERUM DEPARTMENT).

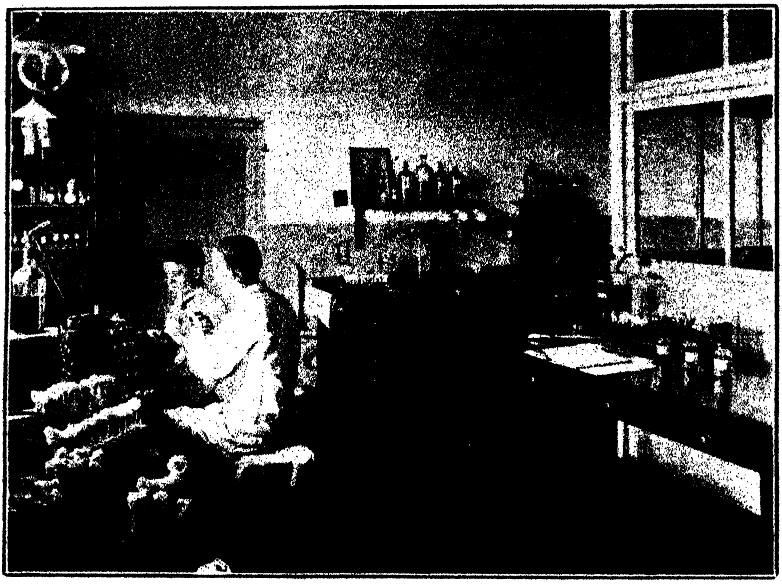
In the apparatus room, bleeding bottles, filtering apparatus, and the like are prepared for use, not only in the Serum Department, but also in all the other laboratories.

Vaccine Department.—A large room on the first floor of the south wing is occupied by the Vaccine Department, which is equipped with all the necessary appliances of the modern bacteriological laboratory.

Within the room a special cabinet has been built, which it is proposed to supply with sterile air. The more difficult operations of bacteriological technique, such as the production of Noguchi's vaccine from the testicles of rabbits, may then be carried out there with every chance of success.

In the production of the ordinary vaccine, the methods used are similar, in many respects, to those employed by Salimbeni, of the Pasteur Institute, Paris.

It is believed that the vaccine technique of the laboratories leaves little to be desired.



VACCINE DEPARTMENT.

Tuberculin Department.—Owing to the fact that certain tuberculins on the local market had been found to be totally ineffective, the tuberclin test in Australia had become very largely discredited.

It was obviously desirable, in the interest of the physician and the veterinarian, for the Commonwealth Serum Laboratories to attempt to create a demand for tuberculin, and to meet that demand with an article which conformed to the classical requirements of Koch.

The Tuberculin Laboratory is fitted with a specially large incubator for the growth of the cultures of B. tuberculosis. It has also a very large fume cupboard, containing, firstly, a sterilizer, in which the cultures are sterilized after they have attained the age of six to eight weeks; and, secondly, evaporating baths, on which the killed cultures are reduced to one-tenth of their volume, in the production of crude tuberculin.

Apparatus is also provided for filtering the crude tuberculin, so that a transparent, sterile filtrate is obtained, to which .5 per cent. carbolic acid is added. This constitutes the old tuberculin of Koch. Very many tuberculins have been made by Koch, and since his time, but it seems very doubtful whether any of them is superior to his original old tuberculin.

In this laboratory, at the present time, an attempt is being made to classify the strains of the Australian tubercle bacilli. For that purpose material is being received from Bendigo, where a Commonwealth and State survey of the tuberculosis of miners is being made.

Bio-chemical Laboratory.—In the bio-chemical laboratory the plasma received from the Serum Department is concentrated. This plasma is produced in animals which have been immunized against the toxins of B. diphtheria or of B. tetani.

Attempts have been made, on a small experimental scale, in other parts of the world, to concentrate other sera. In this regard, more especial reference can be made to dysenteric and meningococcal sera. These attempts, however, have not been sufficiently successful to induce serum makers generally to adopt the practice in the production of sera for commercial purposes.

CONCENTRATION ROOM: BIO-CHEMICAL LABORATORY.

Attached to the concentration room is an experimental bio-chemical laboratory, where experimental work is carried out on a small scale, to elucidate the chemical difficulties arising in the concentration of serum, the making of toxin, or any of the other processes carried out in the laboratories.

In a second bio-chemical laboratory, the re-agents required for the Wassermann reaction and other complement fixation work are made. A considerable amount of complement fixation work has actually been done here.

Diagnosis Laboratory.—In the Diagnosis Laboratory, material is dealt with which comes to the laboratories for the isolation of bacteria for the making of products. Diagnostic agents for the use of clinical bacteriologists and other medical men are produced here, and biological products entering the country, and others sold in the open market, in Australia, are examined.

Director's Laboratory.—In the Director's Laboratory, at the present time, an effort is being made to classify the Australian pneumococci; and a pneumococcal serum specific to type 1 pneumococcus, and another serum, polyvalent, against all the types, are being made and standardized.

Plague Laboratory.—In the Plague Laboratory, up to the present, plague vaccine has been made only in small quantity.

As no visitation of plague has occurred in Australia since the establishment of this laboratory, it has not been greatly used.

Jennerian Lymph Laboratory.—In this building, vaccine lymph is produced for use against small-pox.

The policy of the laboratories in respect of vaccine lymph is to hold large stocks in cool storage (14 deg. to 18 deg. Fahr.), so that in the event of a sudden epidemic of small-pox a couple of million doses might be issued in the course of three or four weeks if the occasion required.

Vaccine lymph kept at this low temperature has been shown by Blaxall and others to retain its potency for many years, and their experience has been confirmed by that of the laboratories here.

The Commonwealth Serum Laboratories were ready for occupation in August, 1918. In the same year epidemic influenza was raging in different parts of the world, and from both South Africa and New Zealand warnings had been received by the Commonwealth Government which caused it to adopt a very strict—and largely effective—quarantine *régime*.

It was also considered desirable that an attempt should be made to produce a vaccine against the B. influenzæ, and against the pneumococci and streptococci, which were the chief causes of the fatal complications in the epidemic.

The production of this vaccine was first undertaken in a small way in November, 1918, but no great demand for the preparation arose until about the end of January, 1919, when the output of the laboratories quite suddenly increased to 170,000 doses per day. In the course of a few weeks, more than 3,000,000 doses were issued.

After the initial stages of the influenza epidemic had passed, the Commonwealth Government determined to supply the vaccine free to all public health authorities throughout the Commonwealth. That policy was responsible for the enormous demand made upon the laboratories. So great was this demand that it required the services of the whole staff to be directed to the production of the vaccine, and the development of the laboratories in other directions was completely interrupted until about April, 1919.

During the epidemic a large temporary staff was engaged in packing and bottling, so that the *personnel* numbered no less than ninety. After the epidemic was over, and the demand for the vaccine had ceased, the services of the bulk of the temporary staff were dispensed with, and the rest devoted their energies to the development of the several departments of the laboratories which have been described above.

At the present moment, the laboratories are able to supply nearly the total demand of the Commonwealth for diphtheria anti-toxin. This preparation is the most important biological product issued by them.

Almost every variety of vaccine has been, and tetanus anti-toxin is just about to be, issued.

Human tuberculin, for use in humans and bovines, is also produced, and bovine tuberculin is being made at the present time.

The Jennerian lymph made by the laboratories is cleaned by glycerine, but it is hoped that at an early date an effort will be made to produce the Noguchi modification of this lymph.

In the Diagnosis Laboratory, the isolation of strains for the making of products should result in a wide and exact knowledge being obtained of the bacterial types found in different Australian diseases. This laboratory should also provide a highly trained staff to undertake field work in the event of other epidemics threatening Australia.

The Legislature of the State of Mississippi has passed an Act appropriating a sum of £70,000 for a new building for the University of Mississippi, to house the Department of Chemistry and the School of Pharmacy. Mississippi has a white population of only 790,000, a little more than half that of Victoria; while the coloured population is about 1,000,000.

The Blow-fly Pest:

Scheme of Biological Experimentation.

Within recent years the study of the biological control of insect pests has made extraordinarily rapid advance, and numerous striking instances have been furnished of the complete success of the employment of natural enemies for the subjugation of injurious insects. The United States, whether because of the magnitude and importance of their primary industries, or because of a quicker and clearer appreciation of the discoveries of biological science, have been more active in the application of "natural" methods to pest control than any other country. The Bureau of Entomology of the United States of America Department of Agriculture and the various State entomological institutions have firmly established themselves as essential and powerful factors in the development of land industries.

In Australia, although relatively the problems whose non-solution raises a more formidable barrier against economic development and industrial expansion than similar difficulties do elsewhere, very little work has been done in the direction of ascertaining whether the alliance of natural enemies can be secured to combat many of the pests which annually reduce the returns from primary industry by hundreds of thousands of pounds.

One of the early acts of the Institute of Science and Industry was the investigation into the sheep maggot flies. It is estimated that in Queensland alone £1,000,000 a year is lost to the sheep-breeding section of the pastoral industry by the ravages of blow-flies. In New South Wales the pest has increased within the last twenty years to an alarming extent, and the loss to that State has reached a huge total. In other States the sheep breeder has been put to great expense in his efforts to mitigate or prevent blow-fly infestation, but only with partial success, and he is still compelled to ceaselessly wage an unequal war against nature.

In the work inaugurated by the Institute concurrently with the investigation of the efficacy of chemical compounds to prevent sheep from becoming attacked, and to minimize the effects of affected sheep, has proceeded the study of the natural parasites of the flies. Recent conclusions arrived at by Professor T. Harvey Johnston, Professor of Biology at the University of Queensland, and Miss Bancroft, and by other investigators, regarding the chalcid parasites of Muscid flies in Australia, suggests the probability of very satisfactory results. An abstract of the findings of Professor Johnston and Miss Bancroft was published by the Royal Society of Queensland, and appeared in Vol. II., No. 5, of *Science and Industry*. Professor Harvey Johnston, who is Scientific Controller of the recently-adopted scheme for the investigation of prickly pear, left Australia a few weeks ago upon a visit to the United States, but before his departure he discussed with

the Executive Committee, after consultation with the Queensland Special Committee, a plan for the modification and enlargement of the scope of work in connexion with the biological side of blow-fly investigation. His recommendations have been adopted.

The scheme may be subdivided under four distinct headings, *i.e.*:—

(1) The formulation of measures against the adult fly;

(2) Those which aim at controlling the larval or pupal fly;

(3) Measures designed to prevent sheep from becoming attacked; and

(4) Those designed to destroy maggots already present, and to minimize the effects, as far as the affected sheep are concerned—*e.g.*, by means of appropriate dressings.

First of all, under this classification comes the study of the adult fly. A considerable amount of work yet remains to be done to determine the various species of flies which frequent sheep, especially those which breed in wool, &c., on sheep. The question then presents itself whether one or more particular species initiate the conditions, and become the means whereby others are induced to attack the infested sheep and aggravate the condition. The determination, if possible, of predisposing factors, and information regarding the seasonal prevalence of the various flies are important factors. Another very important part of the work, in the opinion of Professor Harvey Johnston, and one which may indicate where sheep are more likely to undergo infestation, is to ascertain the "locality prevalence" of the various flies. This could be attempted by a systematic distribution of various kinds of country during the different months—an area of from one to four square miles to be taken, including, if possible, forest land, open forest, downs, plains, sheep camps, and land in the vicinity of creeks and dams. Associated with this work is the systematic use of traps of various kinds, to test which is the most effective for all species or for any particular species of flies, and the identification of the captured flies. Similarly a systematic testing of the various baits in different kinds of traps must be made, and the efficacy of poison bags as a means for attracting flies must be tested. The range of flight of flies from known breeding places must also be determined, and an investigation must be made of the enemies of adult flies—Bombex wasps and various other "policeman flies," as well as dipterous flies (asilid, &c.).

In outlining further investigational work in regard to the larval stages of the flies Professor Harvey Johnston placed first the importance of determining the breeding places (other than in wool, &c., on living sheep) of the various species. This knowledge must be of great value, of course, in the distribution of the chalcid parasites. Once the larva matures it becomes potentially an enemy of the sheep. Following upon this a careful study must be made of the biology of each of the species of flies which frequent sheep, especially the period elapsing between the deposition of eggs or larvæ by the female and the emergence of the adult fly. In the work already done it has been found that even on a well-kept property, where the number of sheep which escape observation is extremely small, sheep were being blown in the

cleanest paddocks. The periods referred to must be determined for the various months and seasons of the year, and the work involves the collection of certain climatological data. When the distinctive characters of the various larvæ have been worked out, Professor Harvey Johnston considers that it should then be possible to determine what flies are attracted to the poison bags in order to deposit larvæ. Further information has yet to be obtained regarding the use of various chalcids against larvæ and pupæ, and also what other organisms destroy fly larvæ.

Both in Queensland and in New South Wales a great deal of work has been done in investigating the parasiticism of various chalcid flies, and the results obtained suggest that several natural enemies of the blow-flies will, in the near future, by means of systematic breeding and liberation, play a very important part in the suppression of the blow-fly pest. Professor Harvey Johnston's scheme provides for the breeding out of pupæ of flies from various localities in the district (and from other districts, if possible) to ascertain the percentage of pupæ naturally infected with one or other of the chalcids during various periods of the year. Hand-in-hand with this work will be carried out a careful study of the biology of the chalcid fly parasites already known in Queensland, in order to determine the best time for their liberation, and the introduction of the other chalcids known to occur in New South Wales as enemies of the flies.

Experiments are now in progress in Queensland with a view to determining the relative values of the various sheep dips, either separately or in conjunction with varying qualities of other known chemical poisons, the object being to discover the best specific for preventing the various kinds of sheep from fly attack, *e.g.*, weaners, lambing ewes, wethers, &c. Jetting, dipping, showering, have been tried, and the results have been made known to pastoralists. The treatment of blown sheep by using various dressings to destroy larvæ already present on sheep or in the wool, also to ascertain the influence of the medicaments in preventing re-infestation, has also been carried out. This branch of the investigations will be continued, and biological work in connexion with these experiments will be undertaken.

Another important phase of the experimental work will be the investigation of the acute affection of sheep sometimes associated with fly infestation. The problems to be determined in this connexion are—(*a*) Under what conditions does it occur? (*b*) Its nature—is it a septicæmia? (*c*) How transmitted? and (*d*) the possibility of making a vaccine and using it (1) in affected sheep, and (2) as a means of protecting other sheep against affection.

E.N.R.

Temperature Control in Industries.

By RICHARD P. BROWN.*

[From information received from time to time by the Institute of Science and Industry, it appears that in many industries in Australia there is a great lack of proper attention to temperature control. In certain metal industries, for example, difficulty is experienced in manufacturing satisfactory articles, and not infrequently the product is entirely spoiled. Troubles of this nature are very often alleged to be due to faulty raw materials, whereas they are really due to lack of control of the temperatures at which various processes are carried out. The scientific control of temperatures at which industrial processes should be performed would necessitate the establishment of some organization which can undertake the necessary investigational work and the standardization of heat-measuring instruments, and can furnish expert advice to those engaged in industry. The temporary Institute has not been able to undertake this work, but it offers a highly important field of activity for the proposed permanent Institute. In this connexion, the following article will be found of interest.]

There is probably no problem offering greater possibilities of attaining efficiency in hundreds of industrial processes than the automatic control of high temperatures. Every manager of an industrial plant, where high temperatures are used in furnaces and ovens, has been confronted with the difficulty of maintaining a uniform or constant temperature on account of the human element.

Literally, hundreds of thousands of tons of coal and millions of gallons of oil are burned to heat American industrial furnaces to a desired temperature. The labourer who has not the slightest idea as to what he is trying to do attempts to control the temperature by hand, with possibly the assistance of a pyrometer or thermometer as a guide. How many managers or executives have thought of the tremendous loss in fuel which occurs, due to the maintenance of an excessive temperature, with its consequent excessive consumption of fuel and spoilage of the product. If, instead of too high a temperature, too low a temperature is maintained, the product may be just as readily spoiled in its heat-treatment, and an excess amount of fuel is consumed to get the temperature up again to the desired point. If there can be automatic temperature control, the human element is eliminated and an accuracy of control attained which is impossible with hand control.

During the past few years, tremendous strides have been made in the automatic control of high temperatures. Mercurial thermometers can have platinum contacts installed in the glass stem of the thermometer, and when the mercury rises or falls to predetermined points, an electrical contact can be made to operate a switch or valve. These same contacts can be applied to nitrogen-actuated long distance thermometers, or to the various types of thermo-electric pyrometers for high

* From the *Journal of the American Society of Heating and Ventilating Engineers*, May, 1920.

temperatures. The problem is one of making a delicate instrument pointer complete an electrical circuit, which, in turn, has sufficient power to operate switches and valves.

The problem is a comparatively easy one for low temperatures, but its difficulty increases with the higher temperatures, where a thermo-electric pyrometer must be used. A thermo-electric pyrometer consists of a thermo-couple formed of two dissimilar wires with the wires joined at one end. When the junction of the two dissimilar metals is heated it produces a small electro-motive force, depending upon the temperature. The electro-motive force can be used to actuate a millivoltmeter, which is nothing more than a voltmeter graduated in thousandths of a volt.

For temperatures up to 2,000 degs. Fahr., it is common practice to use a thermo-couple formed of base metals, one wire being nickel chromium and other nickel aluminium. Such a thermo-couple produces 40-1,000ths of a volt, or 40 millivolts, for a temperature of 2,000 degs. Fahr. For higher temperatures up to 3,000 degs. Fahr., platinum wires must be used for the thermo-couple, and it is common practice to use one wire of platinum-rhodium, the other chemically pure platinum; such a thermo-couple produces only 20 millivolts, or 20-1,000ths. of a volt, for a temperature of 3,000 degs. Fahr.

One can imagine that, with these very feeble currents—thousandths of a millivolt—it is impossible to bring a pointer against contact devices to actuate a switch or valve. The pointer on an instrument of this character can be readily blown across the scale by the slightest current of air, unless protected by its housing. To cause such a delicate pointer to perform operations requiring much power, it has been found necessary to depress this pointer on contact-making devices which, in turn, can complete the circuit to operate the switches. The pointer is depressed at intervals usually of one every half-minute or minute. There is a central or neutral zone, and on each side of this a contact which represents the low and high sides.

Let us assume that we are maintaining a temperature of 2,400 degs. Fahr., and that we wish to maintain this within 20 degs., plus or minus. As soon as the temperature has risen to 2,420 degs. Fahr., the pointer when depressed on the contact device will open the circuit; likewise, when the temperature falls to 2,380 degs. Fahr., the pointer will be depressed on the low contact, which, in turn, will close the circuit. The contacts, which are made and broken when the pointer is depressed on the contact table, are tungsten tipped. The total current passing through these contacts as a relay is used does not exceed 50 milliamperes. The relay is actuated by the opening and closing of the contact, and the relay in turn operates a solenoid, which causes the switch mechanism to open and close. Switching mechanism is, of course, required for electric furnaces. In place of the switching mechanism we can cause the solenoid to operate a valve for the control of gas or oil.

The rapid increase in the number of electrically-heated furnaces and ovens facilitates the ease of handling temperature control, for, without question, the automatic control of an electric furnace offers fewer problems than where oil, gas, or coal must be controlled. Furthermore, the extensive adoption of pulverized fuel for firing also increases the possibility of automatic temperature control, which is not practicable where coal itself is used.

TEMPERATURE CONTROL IN INDUSTRIES.

We are just on the threshold of tremendous developments in the automatic control of temperature in thousands of processes. Without doubt, we will see an extensive use of automatic control in the next few years, and this will mean the elimination of one of the most difficult problems in many manufacturing plants. With a continuous effort in this country for greater efficiency and uniformity, one realizes the stumbling block present where there is hand-control of temperature by an employee, who may or may not control the temperature properly, just as he desires. In automatic temperature control, we have one more step forward in increasing efficiency and uniformity in American manufacturing processes.

The important requisites for industrial research are often unconsidered by manufacturers, who, in endeavouring to select a research chemist, are likely to regard every chemist as a qualified scientific scout. The supply of men capable of working at high efficiency as investigators is well below the demand; and chemists having the requisites and spirit of the researcher are indeed difficult to find by ones experienced in the direction of research. All research professors know that the finding of a skilled private assistant—one who possesses not only originality, but also sound judgment and intellectual honesty—is not easy, because it frequently involves the gift of prophecy on the part of the searcher. It has been truly said that the "seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

—*RAYMOND F. BACON.*

"The Administrator of Industrial Research Laboratories."

Fixation of Nitrogen.

During the war, Germany and the Allies were all experimenting with the methods for the fixation of nitrogen, primarily for war purposes, but at the same time useful for agricultural purposes, and to render each country independent of Chilian nitrates.

The original Haber process was installed on a large scale by Germany, under the control of the Badisch Anilin and Sodafabrik, at Oppau, near Ludwigshaven; but a modified process, by which the pressures used were reduced from 600 to 200 or 300 atmospheres, was established in Germany, and at the time of the armistice was producing over 600 tons of synthetic ammonia a day, or sufficient to make half a million tons of ammonium nitrate per annum. At the same time, England was producing only a few pounds per day in experimental plants; but scientists had not been idle in France, England, or America. It took Germany over five years to develop the Haber process, and its secrets were most jealously guarded. In England, a process was worked out, and was to be put into operation at Billingham. In addition, valuable discoveries, now covered by twenty patents, were made during the investigations, which have brought England abreast of German results, and in some respects in advance. In America, as in Germany, the original Haber pressure under which the gases (hydrogen from water gas chiefly, and nitrogen from the air) were brought into combination was reduced; and the Degendre, or Generel Chemical Company's modified process, uses a pressure of only 150 atmospheres. The relatively high temperatures (600 degs. C.) at which the Haber process was worked has remained unaltered in all countries.

In France, a new process was patented by M. Georges Claude, by which the pressure was increased to 1,000 atmospheres (14,000 lbs. to the square inch) without reducing the temperature at which the combination is effected.

The plant required by the Claude process is both simple and cheaper than the German process, by an amount which is estimated all round as at least 25 per cent. There is great difficulty in forcing nitrogen to enter into combination with other gases unless brought into intimate contact, and this reluctance is accentuated where the gas is dealt with in mass, and at comparatively low temperatures.

By thus increasing the pressure to 1,000 atmospheres, the yield of ammonia is increased fourfold up to 50 per cent., while the speed of reaction is commensurately increased. The power required for compression is admitted to be greater than at 200 atmospheres, but, along with certain advantages, the total power expended per ton of synthetic ammonia produced is no larger than what is required for compression at 200 atmospheres. In the German (Haber) process, the pressure has to be constantly maintained through a lengthy chain of operations, and the condensation of the ammonia has to be secured by water injected at the high pressure; whereas in the Claude process the compression is effected very readily by special compressors, which work as

readily at 1,000 atmospheres as others do at one-quarter of that pressure, and the condensation in the circulating mass is effected by ordinary cooling water at ordinary pressures. Also, the condensation of the ammonia in the Claude process is effected in a liquefied non-gaseous condition, which provides a valuable source of refrigeration for the succeeding process of the fixation of the ammonia in the form suitable for agricultural use.

In the Haber process, the evaporation of the ammonia to a gaseous form was an additional expense, which is unnecessary in the Claude process, as the ammonia, being in a liquid form, passes readily to the gaseous state without distillation.

One of the best testimonials to the credit of the French improved process is afforded by the fact that the working capital required for the Chemical Manufacturing, of La Grande Paroisse, incorporated to work the patents in France and her Colonies, has been subscribed by the St. Gobain Company, one of the most powerful and strictly conservative undertakings in France.

The Cumberland Coal Power and Chemical Limited have secured from the French owners the "Claude" process for the production of synthetic ammonia, and have the sole and exclusive rights for Great Britain and Ireland, South Africa, the Commonwealth of Australia, New Zealand, and India.

As the British Government did not continue with the subject after the signing of the armistice, the large works erected at Billingham were not put into operation; and, in November, 1919, the Secretary of the Ministry of Munitions announced that the Government had decided to leave further development to private enterprise, and that the Minister was prepared to receive offers for the acquisition of the partly constructed factory from persons or firms in a position to develop successfully the fixation of atmospheric nitrogen.

As soon as the full-size commercial unit of the Claude process is in operation in France an English Company, to be known as the "Atmosphere Nitrogen and Ammonia Products Limited," will be formed with a capital of £2,500,000, and it is proposed that this new company shall acquire from the shareholders the whole of the share capital of Cumberland Coal Power and Chemicals Limited, and erect a synthetic ammonia plant, &c., on freehold land adjoining the Allendale coke oven plant of the Cumberland Company.

The ammonia will be used to manufacture ammonium sulphate, and the plant installed will be capable of producing 50,000 tons of sulphate per annum. A small plant will be erected for the production of chloride of ammonium, which will be introduced and popularized as a fertilizer, with the ultimate idea of making chloride instead of sulphate, as hydrochloric acid is cheaper than sulphuric. It is hoped to provide for all the British requirements of nitrogenous manures, and enable the farmer to fertilize intensively and to scientifically cultivate additional land. It is also contended that the successful carrying out of the scheme to its full extent will make England independent of the importation of Chilian nitrates, as the whole of the nitric acid, nitrate of ammonia, cyanides, and various ammonia compounds will be produced in the country at a low cost.

M. Georges Claude has linked up his new process of manufacturing synthethic ammonia with the conversion of the ammonia into ammonium chloride for agricultural purposes. His idea was that the success of the synthetic process would depend upon the increased employment of the product in agriculture, and that as hydrochloric acid was cheaper than sulphuric, the synthetic ammonia should be neutralized with the former acid. He devised a modification of the classical solvay ammonia soda process for the manufacture of bicarbonate of soda, consisting of decomposing large quantities of sodium chloride ('brine) with the aid of ammonia and carbonic acid gas.

This results in the separation and precipitation on one side of ammonium chloride and on the other of sodium bicarbonate, utilizing the alternate precipitation method due to Schreib, by means of which for each ton of fixed nitrogen in the form of ammonia three tons of bicarbonate of soda are recovered.

The process may be briefly summarized as follows: —

Taking as the basis of operations a saturated solution of ammonia and salt, and adding carbon dioxide, bicarbonate of soda and chloride of ammonia are formed, then by adding further ammonia and carbon dioxide, neutral carbonate of soda is obtained, and chloride of ammonia is precipitated. The carbonate of sodium, then in solution through the addition of further carbon dioxide, is transformed in bicarbonate of sodium, which in the presence of chloride of ammonia causes the precipitation of the bicarbonate of soda, and a solution of chloride of ammonia is once more reconstituted. On the addition of more salt and carbon dioxide, the same cycle of operations is started over again, in the same solution, indefinitely. After having twice operated as above, chloride of ammonia is still produced 97 per cent. purity.

M. Claude has also perfected a method for the production of hydrogen from producer gas, which gives better results as to purity and cost than the iron contact process, the Linde-Frank Caro or the Badische Anilin catalytic process. The new French method of producing hydrogen forms an integral part of the Claude synthetic ammonia process developed at Monterean, in the Grand Paroisse Company's Works.

E.M.

Mangrove Tanning.

(Summary of Report furnished to the Institute of Science and Industry by the Queensland Tanning Committee on a Method for obtaining an Improved Colour in Mangrove-tanned Leather.)

This summary of the report furnished by the Committee is intended to present the result of their work in brief. As the report suggested further investigation, it was considered preferable to publish an abstract rather than the full report.

The material investigated was a mixture of red mangrove (*B. ruginera Rheedi*) and black mangrove (*Rhizophora Mucronata*). The object of the work was to devise a method by which this material could be used to produce sole-leather free from the odour and red colour usually associated with mangrove tannage.

Experiments directed towards an actual bleaching of the extract were without practical success, and the precipitation method to be described was the only procedure that furnished promising results. It was found that the precipitation from the extract of sufficient aluminium salts to remove about 20 per cent. of the tannins present produced an extract that furnished a much lighter coloured leather than the untreated solution.

Extract of specific gravity about 1.05 requires the addition of about 1 lb. of aluminium sulphate to every 40 gallons, and to cause precipitation about 1 lb. of soda ash in the form of strong solution needs to be added. This amount of carbonate varies with different samples of bark, and the correct volume can be ascertained by testing a small portion of the extract with measured volumes of the carbonate solution, after addition of the sulphate. The precipitate, which requires about twenty-four hours to settle properly, carries out of solution some tannins and sufficient colour-forming material to considerably modify the appearance of leather subsequently tanned, which is brown in colour and lighter in shade than that formed by untreated material.

The treatment described reduces the acidity of the extract, and a method is suggested for restoring this to its original value. The sulphuric acid required for this purpose amounts to about one-quarter of the weight of soda ash used. A lime-water test was used to control the acidity, but it is of doubtful accuracy under the conditions described, and it may be suggested that a better method, probably physico-chemical, might be devised.

Concentrated treated extracts were also prepared and tested in particular as a substitute for imported extract for "drumming" tanned hides. It is customary for tanners to give the hides a final treatment with fish oil, and sometimes a little concentrated extract is worked into the hides at the same time. It is claimed that this treatment improves the leather. For this purpose the mangrove extract was found to be at least as good as the imported extract. It was suggested that this process of adding extract to leather was worthy of investigation to ascertain to what extent the extract was fixed on the fibres, and not merely mechanically worked into the leather.

Some costs were furnished based on a price of £15 for wattle and £7 per ton for mangrove bark, which indicate that a saving of about £80 per week would be effected on a weekly output of 500 hides. The cost of concentrated extract was estimated at about £19 per ton.

The Committee finally recommended that a series of large-scale experiments, using whole hides, should be carried out before establishing the process on a commercial basis.

Vitamines.

By R. G. LINTON, Royal (Dick) Veterinary College, Edinburgh—Published in the *Veterinary Review*.

For those associated with the nutrition of man and animals the last decade has been a period of peculiar interest, for during it discoveries have been made which throw light on the causes of certain diseases that for long have been surrounded with doubt and often erroneous conjecture.

It is now not only known that scurvy, beri-beri, and rickets are due to dietetic errors, but the cause of each disease has been shown to be due to the absence in each case of a certain specific substance which is essential for health or even life itself. The previous conception that a diet would be "complete" if it contained a sufficiency of energy and of protein, fats, carbohydrates, and mineral matter in proper proportion is now shown to be faulty, and that if wanting in certain specific substances the diet, however plentiful and varied it may be, fails to meet physiological requirements.

These specific substances, and there are more than one, are most commonly known, as a group, as *vitamines*. As they are of such profound importance to health, the Medical Research Committee has considered the time opportune to publish a report* of the present state of our knowledge concerning them, though there are many important features connected with them yet to be cleared up. To those interested in vitamines the report will be very welcome, since to keep in touch with and to follow clearly the progress that has been made in the last few years has not been easy.

Of diseases due to nutritional deficiencies scurvy is probably the oldest. It has been known and dreaded for ages; it was more or less successfully treated over 300 years ago, and efforts, not altogether in the wrong direction, were made to prevent it. "Scurvy-grass" (*Cochlearia officinalis*) earned its name from its use as an anti-scorbutic when medicine, as we know the science to-day, was very juvenile. Thus William Salmon in 1685 tells us that "essence of scurvy-grass cures the scurvy . . . and many other diseases," that "the juyce helps Ulcers of the mouth and cleanses rotten Gums (scurvy)." But scurvy in Salmon's time was regarded as a disease "proceeding of repletion." Many years elapsed between the publication of the *London Dispensatory and Praxis of Chymistry* and the dawn of understanding as to the real cause of scurvy. In 1881 Lunin discovered that mice could not live on a diet composed of caseinogen, milk-fat, milk-sugar, and the ash of milk, and said, "It follows that other substances indispensable for nutrition must be present in milk besides caseinogen, fat, lactose, and salts." Though Lunin did not know it, the summation of his investigation was probably the first shadowy forecast of the remarkable discoveries with which this report is concerned. In 1897 Eijkman showed that beri-beri was due to feeding on a one-sided diet of polished rice, and that if the pericarp with the aleurone layer of the endosperm, which together form bran, were included in the diet beri-beri did not result. But the bad effects that followed such feeding he attributed not to the removal of substances that are in themselves

* *Report on the Present State of Knowledge concerning Accessory Food Factors (Vitamines).* Medical Research Committee Special Reports Series, No. 38. London: His Majesty's Stationery Office, 1919, p. 107. 4s. nett.

vital for the well-being of the body, but to the removal of something that "was necessary to neutralize the otherwise deleterious effect of a diet over-rich in starch."

The year 1906 marks a turning-point, or perhaps one should say starting-point, in the study of vitamines, for it was then that Professor Gowland Hopkins took up the scientific study of the subject. It is quite clear that Gowland Hopkins brought a different mental attitude to bear upon deficient diets than did the earlier investigators, for in 1906 he wrote: "In diseases such as rickets, and particularly in scurvy, we have had for long years knowledge of a dietetic factor; but though we knew how to benefit these conditions empirically, the real errors in the diet are to this day obscure. They are, however, certainly of the kind which comprises these minimal qualitative factors that I am considering. Scurvy and rickets are conditions so severe that they force themselves upon our attention, but many other nutritive errors affect the health of individuals to a degree most important to themselves, and some of them depend upon unsuspected dietetic factors." His later work has been described as undoubtedly marking "the beginning of a full appreciation of the importance of what Hopkins has termed the *accessory factors of the diet*."

Following Hopkins' pioneer work there soon accumulated an ever-increasing knowledge of the so-called vitamines, so that at the present time three distinct substances have been identified by their physiological action. Though their chemical nature is yet unknown, knowledge of their function has passed the elementary stage, and from the qualitative into the quantitative. Their location and general distribution in plant and animal tissues have been and still are being studied, so that plants have now acquired another value in accordance with the presence or absence of any of these factors.

There are some specially outstanding features in connexion with vitamines. The small amount normally ingested is out of all proportion to their physiological importance; thus 1 gramme of raw cabbage or 2.5 c.c. of raw swede juice given to a guinea-pig daily will prevent the appearance of scurvy.

They are present in natural foodstuffs as "instinctively consumed by men and animals." It is believed that they are only formed in the tissues of plants, that no animal body can synthesise them, but being taken into the body of herbivores, they are thus available to carnivores. Nursing mothers denied a sufficiency of the right sort of vitamines fail to secrete them in the milk, and thus the sucking offspring fail to get adequate nutriment. They are present only in certain plants and tissues and in certain parts of the tissues, so that the artificial preparation of natural food may, and sometimes does, so impoverish it that it is no longer a "food" in the true sense of the word.

The three accessory (*essential* is more descriptive than *accessory*) food factors which up to the present have been differentiated are:—

(1) An anti-neuritic or anti-beri-beri factor, the "water-soluble B" growth factor of McCollum and his co-workers.

(2) An anti-rachitic or "fat-soluble A" growth factor.

(3) An anti-scorbutic factor.

The *anti-neuritic vitamine* prevents beri-beri in man, or its analogous disease in birds, avian polyneuritis. It is necessary for the

promotion of growth in young animals. It is found in almost all natural foodstuffs, but chiefly in the seeds of plants and eggs of animals. It is present in considerable amount in such highly cellular organs as the liver and brain, and in flesh but little. Yeast cells and yeast extracts such as the commercial "marmite" are rich in the anti-neuritic factor. Its distribution is general in the seeds of legumes, but in those of cereals it is concentrated in the germ and in the aleurone layer of the endosperm. Beri-beri is caused by feeding too exclusively on a diet of milled cereals such as polished rice and white flour, from both of which the germ and "bran" are removed. Polyneuritis in birds has been produced experimentally by feeding pigeons on decorticated and degermed cereals. This vitamine withstands desiccation for long periods, and has a considerable resistance to heat. If during the baking of whole-meal bread or biscuits the temperature does not rise above 100 deg. C. the vitamine is not destroyed.

The *anti-rachitic vitamine* is necessary for the maintenance of health in adults, and it has been suggested that war œdema may be due to a lack of this factor in the diet. It is present in certain fats of animal origin and in green leaves.

Cream, butter, beef fat, fish oils, and egg yolk are specially rich in it. It is present in very small or negligible amount in vegetable oils. While green-leaf vegetables contain this factor, root vegetables are deficient in it.

The *anti-scorbutic vitamine* is necessary for the prevention of scurvy. It is present in fresh vegetables, and to a much less extent in fresh animal tissues. It is especially abundant in cabbage, swede, turnip, lettuce, watercress, lemon, orange, raspberries, and tomatoes. Meat and milk possess a definite but low anti-scorbutic value. This vitamine is very susceptible to the effect of heat, drying, or other methods of preservation. All dry foods and tinned vegetables and tinned meat are deficient in anti-scorbutic properties.

While limitation of space does not permit of an extended review of the full significance of vitamines or of further extracts from the report, there are certain features in connexion with these interesting and all-important substances that should not be overlooked by the veterinary practitioner or research worker. Rickets, scurvy, and beri-beri are definite diseases that may be regarded as the culminating effect of prolonged feeding on vitamine-deficient rations. The same erroneous method of feeding may, and almost certainly does, produce a condition of "non-health" to which no definite name can be given. Further, it may, and again almost certainly does, so impoverish the natural disease-resistance of both men and animals, that a "text-book" disease may supervene, in connexion with which there may be some confusion between cause and effect. It is possible that this is not always appreciated. The feeding of farm animals to-day is essentially artificial, and it is specially important to keep this fact in mind when considering the diseases of sheep. An investigation into sheep diseases would be one-sided, and possibly unproductive, if limited to a bacteriological inquiry.

There has been shown to be a close association between the occurrence of tuberculosis and the absence of protective vitamines which is not without significance.

It is now, one may say, an established fact that pregnant and nursing mothers must be supplied with suitable and abundant vitamines if the fœtus *in utero* or the sucking offspring is to thrive, and it has been shown that children brought up on cow's milk develop rickets more commonly during the winter months, that is, when the cow's diet is "more artificial and may contain less of the anti-rachitic factor." Thus it is that cow's milk may have a value, both for children and calves, that will vary with the nature of the food the animal is given. In this connexion it is well to note that in all probability "extracted meals," which are subjected to steam for an hour under a pressure of 20 lbs. per square inch for the removal of the solvent, have a nutritive value less than feeding cake, which is never, or very rarely, exposed to a temperature of 100 deg. C. at normal pressure. Extracted meals have probably a low protective value.

The anti-scorbutic vitamine is destroyed by heat, especially if the heating is prolonged. A higher temperature for a shorter period is not so harmful. The prolonged stewing or steaming of meals and foods for calves and pigs is therefore contra-indicated.

Deficiency of vitamines in the food of adults is more likely to produce demonstrable effects during periods of hard physical work or exposure to trying climatic and similar conditions that make an unusual drain upon the stamina of the individual. It is not, therefore, altogether beyond the realm of possibility that war pica and the debility of old and overworked horses may be in part due to a deficiency or unsuitable supply of vitamines, and not, especially in the former case, chiefly caused by hard work, lack of general nutriment, and especially of bulk. In this connexion Satre's experiments in France* are of interest. It is known that dry cereals have little or no anti-scorbutic properties, whereas germinated cereals and legumes have. Satre steeped his horses' oat ration in water for sixty-two hours at 20 deg. C. before feeding, and obtained, he said, excellent results thereby. Though Satre (having in mind Bergame bread, "pain naturel de Fruges," such as is used by man) attributed the beneficial results to the physical and chemical changes that occurred, it is not altogether impossible that the increase in the vitamine content that naturally followed such germination may have been, in part at least, responsible for its increased feeding value. Be that as it may, Satre's experiment is suggestive of the need for further inquiry.

The work of Dr. and Mrs. Mellanby on the cause of rickets is now so well known that no further mention of it need be made here. It has indicated quite clearly that the diet of pregnant and nursing bitches needs careful attention, and what applies to the dog and the child is probably of equal importance for farm stock.

It may give satisfaction to the agriculturist to know that margarine when composed chiefly of vegetable fats cannot, in a food sense, be a substitute for butter. As an unctuous lubricant for bread of a more or less unpalatable nature, and possessing a certain heat value, it is no doubt worth consideration, but there its utility ends. Similarly, synthetic milk can never replace the genuine article.

* *Rev. Path. Comp.*, 1919, XIX., 17–19. (See this *Review*, 1919, III., 270.)

Scientific and Technical Societies.

Abstract of Proceedings.

LINNEAN SOCIETY OF NEW SOUTH WALES

MACLEAY CENTENARY.

The centenary of the birth of Sir William Macleay was commemorated at a special general meeting, held on 14th June. The President (Mr. J. J. Fletcher, M.A., B.Sc.) delivered an address on "The Society's Heritage from the Macleays." A number of Macleayan relics were also exhibited.

ORDINARY MONTHLY MEETING.

(Held on 30th June.)

Papers Read:

1. Notes on Some Australian *Tenebrionidæ*, with descriptions of new species; also of a new genus and species of *Buprestidæ*. By H. J. Carter, B.A., F.E.S.

Thirty-three species of *Tenebrionidæ* belonging to 18 genera (of which one is proposed as new) are described as new. As a result of the comparison by Mr. K. G. Blair of specimens, sent for inspection, with the types in the British Museum, a number of mistaken identifications are corrected and further synonymy suggested. A re-examination of the species of the closely allied genera *Daedrosis*, *Licinoma*, *Brycopia* and their allies has led to considerable modifications of tabulations previously published.

2. On the Male Genitalia of some Robber-flies belonging to the Sub-family *Asilinæ* (Diptera). By G. H. Hardy.

The results of a study of a number of species of Australian Robber-flies belonging to the Subgenus *Asilus* indicate that the male genitalia afford a satisfactory basis for identifying the species. Eleven species (of which one is described as new) are dealt with, and their male genitalia figured.

Mr. E. Cheel exhibited herbarium specimens, together with samples of timber taken from two distinct forms of *Callistemon viminalis* (Sol.) Cheel, showing the following distinctive characteristics:—

(1) Calyx-tube glabrous; bark of a thick corky appearance similar to that of the common "Broad-leaved Tea Tree" (*Melaleuca leucadendron* var, *albida* Sieb. Cheel). (2) Calyx-tube silky-hairy; bark of a more or less fibrous nature.

He also exhibited specimens of two forms or varieties of *Callistemon pachyphyllus* Cheel, showing the following characters:—

(1) Flowers of rick dark crimson similar to the type specimen, but the leaves very narrow.

(2) Flowers of a greenish-yellow colour and leaves narrower than the type. The two latter forms are from Coff's Harbour, whilst the type is to be found at Bullahdelah, Byron Bay, and in Queensland.

Mr. G. A. Waterhouse exhibited a male *Tisiphone rawnsleyi*, which he had mated with a female *Tisiphone abeona*, together with the five butterflies reared from eggs laid by the female. The male *T. rawnsleyi* was reared from a larva found at Mooloolah, Queensland, which pupated at Sydney on 9th September, 1919, and emerged on 18th October, 1919; the female *T. abeona* from Sydney emerged on 10th October, and the pairing took place the same day. The butterflies were placed in a mosquito net hung on a clothes line, and the actual mating was observed, the female was then caged over a growing plant of swordgrass (*Gahnia* sp?) and ten fertile eggs were laid on 20th and 21st October, which emerged in 15 and 16 days. The young larvæ were left undisturbed, the only artificial condition being the surrounding wire of the cage. Early in February, 1920, five pupæ were found, and these produced three males and two females from 21st to 29th February, all being very similar in markings. Two

further matings of these first generation hybrids were obtained and the young second generation larvæ are now under observation. As seen from the specimens exhibited the first generation hybrids combine the characters of both parents, the broad orange band of the forewing of *abeona* being very much reduced in size and much paler in colour. When it was necessary to keep the specimens alive for more than a day, they were artificially fed with a mixture of honey and water. He also exhibited for comparison a series of *Tisiphone abeona* from Eastern Australia showing the northern and southern forms and the wonderful variation existing at Port Macquarie.

ROYAL SOCIETY OF SOUTH AUSTRALIA.

Meeting held in June. Chairman, Sir Joseph Verco, M.D., F.R.C.S. (President).

Papers:—"A Revision of the Australian Noctuidæ," by A. Jefferis Turner, M.D., F.E.S.

This is a critical revision of the Australian species, some 500 in number, based on Sir Geo. Hampson's work, so far as the end of the *Acontianæ*. With them the *Agaristidæ*, usually regarded as a distinct family, are included as a subfamily.

"Contribution to the Orchidaceous Flora of Papua (British New Guinea)," by R. S. Rogers, M.A., M.D., and C. F. White, F.L.S.

ROYAL SOCIETY OF TASMANIA.

At the June meeting (Mr. L. Rodway, C.M.G., Vice-President, in the chair) the following members were elected:—Dr. W. I. Clark, Messrs. J. H. Gillies, and F. B. Cane.

A paper by Mr. G. H. Hardy on "Australian Stradiomiidæ" was read. The paper included description of new species.

Messrs. H. H. Scott and Clive Lord read a paper on "Studies of Tasmanian Mammals, Living and Extinct, Part II." The paper was divided into two sections, and dealt mainly with the skeleton of *Nototherium mitchelli* recently obtained from the north-west coast of Tasmania. The first section gave a *résumé* of the history of the genus, and the second dealt with the osteology of the cervical vertebræ. The authors desire to show that the species was one essentially adapted for aggressive warfare. They point out that whereas the skulls of *Nototherium mitchelli* and *N. tasmanicum*—at least—(with the possibility of other species) are equally large and weighty, yet their cervical vertebræ show marked differences, one being an exaggeration of the standard of the modern wombat in about the same ratio of power (*N. tasmanicum*), while the other shows an additional power with interspinal muscles and paddings, suitable to the resisting of great shocks in the longaxis of the head and vertebræ.

Mr. Rodway delivered an illustrated lecture on the "Overland Route to the West Coast." The lecturer traced the course of the proposed road, and dealt with the geographical features of the country through which it would pass.

ROYAL SOCIETY OF NEW SOUTH WALES.

At the July meeting, a paper on *Aphrophyllum Hallense*, gen. et. sp. nov. and *Lithostrotion*, from the neighbourhood of Bingara, New South Wales, was read by Stanley Smith, M.A., D.Sc., F.G.S. (communicated by Professor W. N. Benson). The corals studied were obtained by Dr. Benson at the head of Hall's Creek, 16 miles south of Bingara, and are referred by the author to *Lithostrotion arundineum*, and *L. stanvellense*, two species instituted by the late Robert Etheridge, Jnr., for corals from Lion Creek, near Rockhampton, topotypes of which, kindly forwarded by Mr. B. Dunstan, have been studied and described in the preparation of the present note. After a discussion of the genus *Lithostrotion* and its separation into species, the feature of the two species are described and compared with forms in Britain, of which they most resemble respectively *L. irregulare* and *L. martini*, but differ in the stoutness of the columella, the replacement of the tabellæ, and the size and irregularity of the

dissippiments. They have been compared with Belgian, Russian, and American forms also. Aphrophyllum is a composite form of imperfectly contiguous turbinate corallited of a cyathophylloid type, apparently closely related to the genus *Endophyllum*. Four plates are added in illustration of these forms.

Mr. J. H. Maiden, F.R.S., read a paper entitled "Descriptions of Three New Species of Eucalypts." The first is a dwarf mallee-like stringybark, from between Port Jackson and Broken Bay, closely allied to a moderately large tree, one of the earliest to be described under the name *Eucalyptus capitellata*, from which it differs in size, smallness of all the organs, and the great abundance of hairs, particularly on the young shoots. The second species comes from the summit of Mount Jounama, one of the Bogong peaks, at an altitude of about 5,400 feet, 30 miles south of Tumut. It is a large tree, a gum, and the bark falls off in strips as much as 30 feet long. It is allied to the Snow Gum, *Eucalyptus coriacea*, and to one of the Mountain Ashes, *Eucalyptus gigantea*. The third species comes from the drier parts of Western Australia, and it may be spoken of as the dry country representative of the Yate, *Eucalyptus occidentalis*.

Personal.

MR. A. E. LEIGHTON.

One great fact which emerged from the experience of the war was the need for marshalling the resources of industry and science as part of a political and defence policy. Amongst civilized nations the relative capacity for waging successful war is measured by the nature and efficiency of the industries possessed by the opposed communities, for it is on industry, as the producer of wealth, that falls the expense of keeping the nucleus army and navy in time of peace, and to industry that the army and navy look for munitions in time of war. It is therefore of cardinal importance to stabilize essential industries in Australia and secure a stock of trained brains and inventive resource, so that in time of need the industries can be made to function for war.

Protection in itself will not stabilize industry in Australia, for if it is not backed by capable and progressive scientific management, Protection, to be effective, will become a tax which the community cannot afford. On the stability and breadth of the industries rests Australia's capacity for defence, and stabilized industries staffed with efficient scientific workers will secure to Australia the means of supplying the army and navy with vital necessaries in time of war. There is scarcely a natural material required for making articles used in war that is not available somewhere in Australia, and the problem before us is to find the means, by intelligent and sound policy, to insure these available materials being utilized. The solution of the problem lies in co-ordinated work by the Customs and Defence Departments and the Institute of Science and Industry.

It was in order to establish a link between the Defence Department and the Institute of Science and Industry that the Government appointed Mr. A. E. Leighton, of the Defence Department, to the Executive Committee. Mr. Leighton, whose photograph appears in this issue, was born in London, and was educated at the Wesleyan Training College, Westminster, and at the Birkbeck College, University of London. He was assistant to Mr. William Macnab, C.B.E., for some years, and gained a wide experience in general consulting and explosive practice. Research work on explosives and interior ballistics was carried out at this time, and formed the subject of several scientific papers. The work brought him in close association with Dr. A. Dupre, Home Office Explosives Expert, and led to an appointment with the Government of India Department of Military Supply. In 1903 he joined the Royal Gunpowder Factory, Waltham Abbey, and later went to India, where he continued during the period in which the munition factories were modernized under the direction of Sir Chas. Scott.

In 1906 Mr. Leighton served as technical advisor to the Committee appointed to inquire into explosions of cordite at the Ferozepore Arsenal. Whilst on this service he contracted enteric fever, which necessitated leave to England in 1907, and during this visit he was fortunate enough to meet Mr. C. Napier Hake, who was then in

England inquiring for the Commonwealth Government into a proposal to erect a cordite factory. Subsequently, on Mr. Hake's recommendation, Mr. Leighton was invited by the Commonwealth Government to come to Australia and prepare the design of a factory, and to organize the manufacture of cordite. This work was successfully accomplished by 1912, and Australia became self-contained for small-arm cordite.

The first months of the war were occupied in establishing the manufacture of fulminate of mercury; but, as little new work offered in other directions, Mr. Leighton applied for leave to visit India and England to acquaint himself with recent developments. He reached England in June, 1915, at the inception of the Ministry of Munitions, and his services were at once requisitioned by the Imperial Government in connexion with the vast projects that were then being undertaken. At a later date his services were requisitioned for the period of the war, and he remained with the Ministry of Munitions as technical adviser until November, 1918. The earlier period with the Ministry was occupied on the designs of H.M. factories, Queensferry and Gretna, and later he was appointed to the Board of Management, H.M. Factory, Gretna, which employed about 20,000 persons. At the outset of his work with the Ministry he realized that the shortage of chemists and skilled workers must be remedied before adequate production from the new factories could be assured, and, in July, 1915, had gained the support of the Australian Government in this direction. The first chemists from Australia reached England before Christmas, 1915, and by the following October there were, in all, about 100 Australian chemists in the several factories of the Ministry. This movement grew, for, in June, 1916, it was extended to include munition workers, and, as this work was of considerable extent, Colonel Sir Henry Barraclough was sent to London in November, 1916, to act under Mr. Leighton's direction in the supervision of this branch.

In early 1916, the Australian Government had under review a proposal to erect an arsenal, and the appointment of general manager was offered to Mr. Leighton. It was accepted, and an arsenal office established at Australia House, London, from which were directed the technical inquiries into the production of munitions of war, and also the administration of munition workers and war workers. The chemists, engineers, and munition workers were spread through the factories of Britain under a definite scheme, which insured that practically every activity was touched, and under the direction of the Minister a card record of the service of each man sent from Australia was made. There is little doubt that the movement will have a profound effect on Australian industry.

Mr. Leighton returned to Melbourne in April, 1919, and since then has been actively engaged in the administration of the technical section of the Defence Department, which comprises the factories at Maribyrnong, Lithgow, and Brisbane, and the Defence Laboratory and Inspection Departments. He has devoted a considerable amount of time to the design of projected factories which form part of proposals now under consideration by Government.

Mr. Leighton is a Fellow of the Institute of Chemistry of Great Britain and Ireland, and was formerly a member of Council. He is also a Fellow of the Australian Chemical Institute.

REVIEWS.

Inbreeding and Outbreeding.—By E. M. East, Ph.D., and D. F. Jones, Sc.D. (P. 285, with 46 illustrations.) J. B. Lippincott Company, Philadelphia and London. Interest in the effects of inbreeding and of outbreeding is not confined to the biologist, and this, the latest addition to the excellent series of monographs on experimental biology published by American biologists will, therefore, be assured a good reception. As the authors, in an introductory chapter point out, these are old problems intimately bound up with human progress, and the passing of time has not diminished the value to be attached to their solution. Three questions are proposed which show the sociological bearing of the problems —(1) Do marriages between near relatives, wholly by reason of their consanguinity, regardless of the inheritance received, affect the offspring adversely? (2) Are consanguineous marriages harmful through the operation of the laws of heredity? and (3) Are hereditary differences to the human race transmitted in such a manner as to make matings between markedly different people desirable or undesirable, either from the stand-point of the civic worth of the individual or of the stamina of the population as a whole? No attempt has been made towards a detailed application of the conclusions arrived at to sociology, agriculture, nor evolutionary theory, but "it is hoped that the suggestions along these various lines are sufficient to show how such application can be made; but human direction of evolution, either in man or in the lower organisms, is beset with difficulties so numerous and so prodigous that each problem must have its individual solution." The subjects dealt with are "Reproduction among animals and plants; the mechanism of reproduction; the mechanism of heredity; mathematical considerations of inbreeding; inbreeding experiments with animals and plants; hybrid vigor or heterosis; conceptions as to the cause of hybrid vigor; sterility and its relation to inbreeding and crossbreeding; the *rôle* of inbreeding and outbreeding in evolution; the value of inbreeding and outbreeding in plant and animal improvement; inbreeding and outbreeding in man and their effect on the individual; the intermingling of races and national stamina literature.

The Organization of Industrial Scientific Research.—By C. E. K. Mees, D.Sc. McGraw-Hill Book Co., New York, 1920. (Pp. vii + 175.) The author of this book is Dr. Kenneth Mees, the well-known Director of the extensive research laboratories of the Eastman Kodak Co. at Rochester, New York, and the writer of many articles and brochures on different aspects of the application of science to industry. The object of the book is to afford information regarding various types of laboratories, their organization, construction, equipment, and control to persons engaged in industry who contemplate the establishment or development of industrial research laboratories. The author points out that hitherto discussions on the development of research in science which may be applied to industrial evils has been concerned chiefly with an exposition of the advantages to industry of participation in scientific research, and of the importance, national and economic, of an increase in the volume of research work of all kinds. But, together with propaganda in favour of research, there is necessary a study of the best methods of organizing research work for industrial purposes, and of the conditions under which such work should be conducted. The book is designed as a contribution to this latter question.

Dr. Mees strongly insists on the importance of research work on pure theory in connexion with industrial development, a point which is too often overlooked, not only by those responsible for the establishment of national research institutes, but also by those who control industrial laboratories. He rightly points out that the immediate success of the application of scientific methods to industrial processes has often led the executive of commercial enterprises into the belief that such work along directly practical lines is capable of indefinite extension. In this belief a number of laboratories have been started, some of which, at any rate, have been sources of disappointment in consequence of a failure to grasp the fact that if the whole future of an industry is dependent on the work of the research laboratory, then what is required is not merely an

improvement in processes, or a cheapening in the cost of manufacture, but fundamental development in the whole subject in which the manufacturing firm is interested. For this purpose it is clear that something very different from the usual works laboratory will be required, and that in order to obtain progress the work of the research laboratory must be directed primarily toward the fundamental theory of the subject. Dr. Mees draws attention to the fact that in every case where the effect of research work has been very marked, that work has been directed, not toward the superficial processes of industry, but toward the fundamental and underlying theory of the subject. He gives a number of illustrations in support of this statement.

Special chapters of the book are devoted to a consideration of the Internal Organization of Industrial Research Laboratories, Staff, Building, and Equipment, and the Direction of the Work. Useful information is also given to the question of the Design of a Research Laboratory for a Specific Industry. The book may be commended to those who are interested in the question of industrial research in Australia, and especially to those who are in control of large industrial undertakings.

MR. C. S. NATHAN, Member of the Executive Committee of the Institute of Science and Industry.

(For Biographical Notes, see page 509.)

SCIENCE AND INDUSTRY.

VOL. 2.] AUGUST, 1920. [No. 8.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

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Science and Industry Bill Approved.

GENERAL satisfaction has been expressed, both at the passage of the Bill for the permanent establishment of the Institute of Science and Industry, and at the provisions which the Bill contains. The measure has yet to go back to the House of Representatives for confirmation of one or two amendments, introduced at the instance of the Government, while under discussion in the Senate. As these amendments are in consonance with the principles laid down by the House of Representatives for the governance of the Institute, anything but their full and immediate acceptance is therefore extremely unlikely.

In its original form, as was explained in our last issue, the Bill differed in one or two important respects from the proposal submitted to the previous Parliament. Provision was made in the latter for the establishment of Advisory Councils in each State, and for the appointment of three Directors. The new Bill contained no such specific provision for the appointment of Advisory Councils, and the number of Directors was reduced from three to one. In the recent debate, Parliament generally approved of the principle of a sole Director, but pressed for the insertion of a clause empowering the appointment of Advisory Boards in each State. Amendments were, therefore, effected

in this direction, and a new clause was also inserted in the House of Representatives providing that the Institute shall comprise—

(*a*) a Bureau of Agriculture;

(*b*) a Bureau of Industry; and

(*c*) such other bureaux as the Governor-General determines.

These new features were warmly favoured by the Senate; but it was discovered that, while provision was made under which Advisory Boards could be appointed in each State, there was no definite provision for the appointment of a General Advisory Council. Upon the initiative of the Government, this omission was rectified, and the Bill as it emerged from the second Chamber therefore provided that—

(*d*) the Governor-General may appoint a General Advisory Council and Advisory Boards in each State to advise the Director with regard to—

(*a*) the general business of the Institute, or any Bureau thereof; and

(*b*) any particular matter of investigation or research.

A second and a minor amendment, also inserted by the Senate, provided for "a Bureau of Industries" instead of "a Bureau of Industry" in item (*b*) of the new clause, introduced by the House of Representatives, and quoted above.

Assuming that the Bill will be accepted by the House of Representatives in the form in which it left the Senate, the Act will provide all the necessary machinery for securing to the Institute the best scientific and expert advice available in the Commonwealth; and in these circumstances it may confidently be expected that problems of the most urgent national importance will be selected, and that the widest knowledge and experience, and the strictest economy, will be brought to bear upon their solution.

The provision for the statutory recognition of Advisory Boards to deal with special investigations is one that will commend itself to well-wishers of the permanent Institute. The experience of the temporary organization—which the Government naturally availed itself of in formulating the scheme of work—pointed strongly to the desirability of concentrating upon special investigations, and after having made the most careful selection of the persons to whom the work could be intrusted—both scientific and practical—to give them a free hand in the conduct of their inquiries.

Much of the work upon which the present Institute has embarked, and which, presumably, in view of the encouraging results already obtained, will be continued under the new *régime*, appears well adapted to control of this kind. For instance, the prickly pear investigations have been

placed under a representative Board to manage the business side of the inquiry, while the purely scientific work has been left under the untrammelled control of Professor T. Harvey Johnston, a biologist. The Hon. W. Massy Greene, in his second-reading speech, urged the importance of the Director being left free to call to his counsel, in regard to particular problems that have to be studied from time to time, such men as may be considered desirable. In this way, he pointed out, better and speedier results would be secured, and probably far less expenditure would be incurred.

With an Advisory Council at his right hand, and with State advisory bodies available for consultation upon the general business of the Institute, the Director will be able to speedily formulate a definite policy of scientific work for the advancement of Australian industry. There can now be no justification for the fear that the pseudo scientist will triumph. In the past, both the leaders of science and of industry have given their best efforts to secure the establishment of the Institute, and there is no reason why, when the object for which they have so long and unsparingly been working has been attained, they should withdraw their support, and cripple, if not wholly destroy, the newly-formed organization. The *personnel* of the advisory bodies in the past has provided a strong guarantee against either the selection of unimportant problems or the appointment of inexpert investigators. It is inconceivable, therefore, that the new Director will deprive himself of the services of men essential to his own success, or that either Science or Industry will abandon and leave to its fate an organization which, without whose whole-hearted co-operation, must ignominiously and inevitably fail.

—E. N. R.

EDITORIAL

DESTRUCTION OF BIRD LIFE.

Captain S. A. White, who was recently invited by the Commissioners of the Murrumbidgee Irrigation Areas to make investigations and suggestions concerning the bird life of the district, has furnished a report in which he comments upon the ruthless destruction of bird life. The visit was made towards the end of a long period of dry weather, and consequently many birds had left the district, while, on the other hand, some species had been driven into the cultivated areas from the surrounding dry country in unusually large numbers. "These probably attacked fruit," he stated, "which under normal conditions they would never have done." Observations carried out under those circumstances may, he considers, have good effects, as they may be the means of protecting some of the native birds which are doing much good during ordinary seasons, but which in times of drought may levy a light toll for services rendered. Some years previously Captain White travelled through the Yanco district, and found bird life very plentiful, the more useful species predominating. On this second occasion the absence of the majority of birds was very striking, and was no doubt due to the indiscriminate clearing of the natural timber and undergrowth. "Although," he writes, "many of our useful native birds are quite willing to work all day amongst the orchards and crops of man, still they require some of their native cover, and haunts to repair to for the night, and to nest in and bring up their young. This is very noticeable in many of our so-called migratory birds, such as the White-shouldered Caterpillar-eater (Lalage tricolour), Wood Swallows (Antimus). These birds visit the district under observation in great numbers at spring time. They nest in the native pine tree (Callitris), and bring out their broods when caterpillars and other grubs are most numerous upon the irrigation area, and doing great damage to vegetation. It is a certainty that if reservations are not made and some of the native timber saved this army of unpaid workers will not stay to rear their young, but pass on to more congenial situations, and the irrigation areas will suffer a loss difficult to estimate—it being so far-reaching. This applies to many other species, and every inducement should be given for these birds to remain as long as possible in the district. During the visit 5,054 birds were observed; they comprised 60 species. Forty-eight species are without doubt beneficial, eight species are partly so, three species are injurious, one specie (Emu) neutral. After the taking of a systematical census of the area in question, and carefully checking same, the approximate number of birds per square mile is 404, made up as follows:—46 injurious, 36 partly injurious, 322 beneficial."

SOME INJURIOUS BIRDS.

In his recommendations to the Irrigation Commissioners, Captain White urged the appointment of an inspector, who would educate the settlers and enable them to identify bird friends from bird enemies. For providing a sanctuary he indicated a strip of country which could be utilized both for the protection of flora and fauna. Shooting on water canals and channels should be prohibited and, in fact, no shooting should be allowed on the irrigation areas with the exception of scaring and killing injurious birds. Part of the work of the inspector should be to visit the children in the schools, and address them as frequently as convenient. In this catalogue of the worst enemies, Captain White places, first and foremost, the English Starling. The method he advocates for dealing with the pest is to harass the birds by every mechanical and human power, for they are easily scared. Not only are they enormously destructive of fruit and crops, but they are also very dirty birds, being infested with lice. Their nests become a great nuisance in the roofs of dwellings, and they have been known to transmit their parasites to useful birds with disastrous results. Sparrows and imported goldfinches are two other enemies mentioned. Cormorants, or "shags" as they are more commonly known, Captain White strongly defends. A grave mistake, he states, has been made by the settlers in destroying and scaring them away. He is of opinion that "the Commission will do well to give these birds their full-hearted protection, for they are without doubt some of the best friends you have. These birds are persecuted because they devour introduced fish, but that is no business of the Commission. You have no angling business on the areas, and if these rid the water channels of the most destructive enemies, the Yabbies, they are worth much more than their weight in gold. That the Cormorant is ridding the channels of the Yabbies was very strongly illustrated at these localities where the birds rested, for here I found many claws and a few tail fans, rejected by the birds, showing that their habits are the same as in every other part of Australia. All the Heron family are of greatest service to the irrigation settlements, and they also feed largely on Yabbies, so it is absolutely necessary to gazette sanctuaries for them and the Ibis, for they are all indispensable to an irrigation settlement."

POWER-ALCOHOL IN THE UNITED STATES OF AMERICA.

The production and utilization of alcohol for power purposes is making rapid strides in the United States of America. Reference has already been made in this *Journal* to certain industrial enterprises which are manufacturing large quantities of alcohol for power purposes. Another alcohol mixture, called "Fermogas," is now being placed on the American market. In a circular relating to the process for its manufacture attention is drawn to the acute situation which America now faces in regard to petrol, and to the necessity for finding a substitute.

Dr. W. R. Ormandy, one of the leading British authorities on liquid-fuels, has recently expressed the opinion that in a very few years every country producing motor-fuel will require the whole of its own supplies, and that the only solution of the problem lies in the production of power-alcohol.

In Great Britain increased attention is being given to the "power-alcohol" problem. The Imperial Motor Transport Council has established an Empire Motor Fuels Committee, with the following terms of reference:—(1) To take immediate steps to encourage and develop the production and utilization of additional motor fuel supplies, or raw materials therefor, in all parts of the Empire, and more particularly to insure increasing shipments of motor fuels to Great Britain, and, so far as may be necessary, to the Empire overseas. (2) To co-operate with any Government, or incorporated or unincorporated body of persons, in order to further the object set forth in (1) hereof. (3) To offer for the purposes in view bonuses or other rewards, and to incur such expenditure as may be desirable, all such expenditure being subject to the approval of the council.

The British Fuel Research Board has issued a memorandum regarding the use of alcohol as fuel. After referring to its great suitability for certain classes of motor vehicles, Sir Frederick Nathan, a member of the Board, states that quantities are available in the Dominions, where the cost of production is less, and where it is possible to grow vegetable substances containing the starch or sugar necessary for power-alcohol. The matter was being investigated in various Dominions and Colonies. Molasses were very suitable as a raw material. Waste material would probably have to be utilized for distillation purposes owing to the commercial value of anything used for foodstuffs. The memorandum points out that in tropical portions of the Empire there are vast quantities of rapidly-growing vegetation suitable for the fuel, and research work has been initiated with the object of treating such vegetation cheaply.

SCIENTIFIC RESEARCH IN NEW ZEALAND.

Considerable interest is being shown in scientific circles in New Zealand in the work of the Institute of Science and Industry, and Professor T. Harvey Johnston, while on his way to the United States of America, was asked to lecture upon the organization and scope of the activities which the Institute has established. At one meeting of scientists only he explained the nature of the work which the Prickly Pear Board has embarked upon, and his object in visiting America; and on another occasion he explained the functions of the Institute generally before a meeting of members of both Houses of Parliament. Professor Johnston, in a letter to a friend in Melbourne, commented upon the poor salaries paid to scientific men in New Zealand, and stated that in the course of his lectures and personal discussions he emphasized the point that while the inducements offered were poor, it was extremely unlikely that good work would be performed, and that only indifferently trained men, or men of little or no standing, would in future offer their services.

WATER HYACINTH IN CALIFORNIA.

Investigation by the Californian Department of Agriculture has disclosed an infestation in one or two localities of the dreaded water hyacinth. Immediate action is therefore being taken towards its eradication, for it is thought that "California can better afford to expend a million dollars now in eradicating the thing than to have to put up with

it for all time. It eventually will ruin the great majority of beautiful lakes and similar places in California, to say nothing of the damage it will do in irrigation and drainage canals and in navigable water-ways." Australian experience would suggest the wisdom of prompt action and large initial expenditure in an attempt to rid the country of the scourge, which, if unchecked, will do all that the Californian Department of Agriculture predicts that it will do. An illustrated article in *Science and Industry* (Vol. I., No. 4) indicates the extent of the damage the plant has caused in New South Wales and Queensland. Professor Newell, Plant Commissioner of Florida, writing about the plant, states that "there is no way of estimating the enormous loss which this plant has caused to Florida and also to practically all of the other Gulf States. Florida is essentially a land of beautiful lakes. Many of these have become entirely covered with the water hyacinth, and the lakes, of course, are of no further use for bathing, fishing, or boating, and instead of being points which are attractive to tourists, they are merely eye-sores, and resemble nothing so much as marsh lands. During the war a couple of aviators, circling over the central portion of this State, spied what they thought was a beautiful green meadow, and dropped down on it to make a landing. They lit in a vast expanse of water hyacinths with several feet of water underneath, and no one has yet reported how much it cost the Government to get those two aeroplanes out."

SCIENTIFIC ROAD-MAKING.

Professor Whitfeld, of the Western Australian University, has circularized the local governing bodies in Western Australia with respect to a proposed laboratory for testing road-making materials. He points out that a suitable laboratory for testing would probably cost from £1,000 to £1,500, and he suggests that the Government and the various municipalities and road boards might be willing to combine to erect such a laboratory in Perth. In this way some use could be made of the technical staff of the University. Even with the co-operation of this staff, however, the Professor estimates that the laboratory would probably cost from £200 to £300 a year to run, assuming that a considerable number of tests would be required. The circular has already been considered by several local governing bodies, who, for the most part, are agreed as to the value of such a laboratory, but are not prepared to contribute to its maintenance.

In this connexion it may be mentioned that last year the Institute of Science and Industry appointed a special committee to consider the question of establishing a Federal organization in connexion with the Institute to undertake research work in regard to road-making materials, &c. The committee recommended that a central roads research laboratory should be established to work in co-operation with existing State and University laboratories, which would continue to carry out and develop their present work. (See *Science and Industry*, Vol. I., No. 2, pp. 104-108.) The temporary Institute has not been able to take any further action in this direction, and the scheme is one of the many which are awaiting the consideration of the Director of the proposed permanent Institute.

SCIENCE AND INDUSTRY.

In America the Federal Government is spending, through the Office of Public Roads, a sum of £70,000,000 on road-making by way of subsidy on a £1 for £1 basis by the States. Already remarkable improvements have been effected as a result of this action, and a great deal has been done to open up agricultural country, to assist primary producers, and to increase production.

INDUSTRIAL RESEARCH IN GREAT BRITAIN.—ITS ALLIANCE WITH INDUSTRY.

The third Conference of Research Associations, established under the auspices of the British Department of Scientific and Industrial Research, was held in May last. In opening the proceedings, the Marquis of Crewe said that some sixteen Research Associations had already been created, and several more were approaching maturity. In fact, twenty-six were already in full swing, or were almost ripe. It had become almost a platitude that no distinction could be drawn between pure research and the application of research to any special industry. It would be reasonable to claim that the researches carried out by the industrial associations would be wider in scope than those by individual enterprises.

A paper on "The Relation of Research Associations to Existing Institutions for Research" was read by Dr. A. W. Crossley, who said that all great industrial advances had been the outcome of pure scientific research work. Research Associations could not divorce themselves from pure scientific work; rather they must regard the need for it as the main cause of their existence, and devote their energies to an always closer acquaintance with this soul of industrial prosperity. The Government research laboratories should be kept in the closest possible touch with Research Associations; but undoubtedly the research institutions with which the associations must keep in the closest contact were the laboratories of universities and colleges. The associations would be largely, if not entirely, dependent on the universities for a supply of research workers.

Mr. J. W. Williamson read a paper on "The Staffing of Research Associations." Assuming, he said, that the research staffs of the associations were to be recruited from those science graduates of the universities and higher technical colleges, who had already had some training, say, two or three years, in research, it would seem that an initial salary of £400 per annum was the minimum that should be offered to an ordinary member of the research staff.

INDUSTRIAL RESEARCH FELLOWSHIP.

The Mellon Industrial Research Institute, Pittsburgh, has issued its seventh annual report on the system of Industrial Fellowships, which was established on a permanent basis in 1913. According to this system, an industrialist, company, or association of manufacturers having a problem, or group of problems, requiring investigation may become the donor of an Industrial Fellowship by contributing to the Mellon Institute a definite amount of money for a period of not less

than one year. This sum must be sufficient for the purchase of all necessary special apparatus or other equipment, as well as to furnish the salary of the research man or men selected to work on the particular problem. Each Industrial Fellow is selected carefully by the Institute, which provides accommodation for the investigatory work, furnishes the permanent equipment, affords library and consultative facilities, gives careful direction to the progress of the research, and provides an atmosphere which is conducive to productive inquiry. All results obtained during the course of the Industrial Fellowship belong exclusively to the donor.

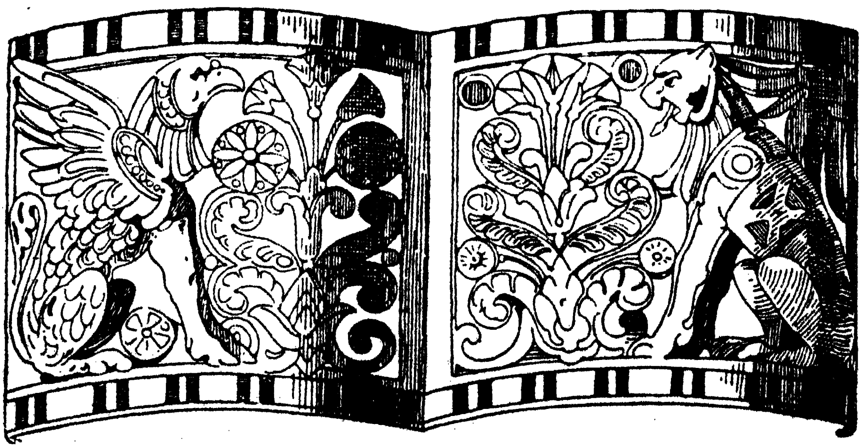
In March last there were 83 "fellows" at work at the Institute, the total amount of the "foundation" sums being £59,000. A number of the fellowships were founded by associations of manufacturers to inquire into problems connected with a variety of subjects, including leather-belting, fibres, magnesia, insecticides, laundry processes, and refractories. The amounts of the individual foundation sums range from £420 to £8,200 per annum.

NEW METHODS FOR CHEAP FUEL.

Costs of heat and power are likely to be much reduced by the use of the new colloidal fuel, described at the recent spring meeting of the American Chemical Society, held in St. Louis. A combination of finely divided coal dust and of waste from stills, which is held together in emulsion form by soap-like substances, this fuel, it is said, will undoubtedly have an important effect upon industry. In view of the many inquiries made from all parts of the country, the paper describing this new factor in industrial economy is produced in full in a recent number of the *Journal of Industrial and Engineering Chemistry*. Its author, Mr. Jerome Alexander, of New York City, gives due credit to all concerned in the development of this latest application of colloidal chemistry—that branch of science which relates to substances in a state of fine suspension, such as may be found in emulsions and gelatins. "What promises to be one of the most far-reaching advances made under the stress of the recent war," writes Mr. Alexander, "when necessity literally was the mother of invention, is the discovery that by means of a suitable fixation, or peptizing agent, and suitable treatment, very large percentages of cheap tars and finely powdered coal waste may be dispersed in fuel oil with a sufficient degree of permanence to enable the mixture to be stored, piped, atomized, and burned practically like fuel oil itself. Since it will at one stroke relieve the drain on the earth's rapidly-diminishing stores of petroleum, as well as lead to the efficient utilization of all kinds of coal waste, such as culm, screenings and dust, inferior fuels such as peat and lignite, and even cellulose waste, such as slabs and sawdust, this new composite fuel may be hailed as a powerful factor in the conservation of our natural resources and as a lasting benefit to mankind. Realizing the vital importance of the Allies' oil supply in the conduct of naval, military, and manufacturing operations, the German submarines bent every effort to destroy tankers. Marshal Foch is said to have cabled America: 'If you don't keep up your petroleum service, we shall lose the war.' While the Allies' navies were dealing with this peril in a most decisive fashion, Lindon W. Bates, of

New York, head of the Engineering Committee of the Submarine Defence Association, with the assistance in laboratory matters of Dr. S. E. Shepperd and other chemists of the Eastman Kodak Company, courteously opened to him, developed a colloidal fuel which, by practically doubling the usefulness of every oil cargo, would of itself have materially assisted the defeat of the efforts of the Hun. Coal or other combustible solid," says Doctor Alexander in explanation, "is prepared for dispersion by being pulverized so that about 95 per cent. passes through a sieve which has one hundred meshes to the square inch. This means, of course, that by far the greatest weight is in particles hundreds and hundreds of times larger than colloidal dimensions." Doctor Alexander also described how this new development in chemistry was employed by war vessels in creating colloidal clouds for smoke screens in order to outwit the pursuing submarines.

The British Department of Scientific and Industrial Research has approved of the formation of a Research Association for the Motor Cycle and Cycle Car Industry, and a grant will be made to the Association from the fund of £1,000,000 made available by the Government.



Nature *versus* The Australian.

By GRIFFITH TAYLOR, D.Sc., B.E., B.A., Associate Professor of Geography, University of Sydney.

All Australians are anxious to see their homeland develop speedily, so that it may come as soon as possible into its proper place in the comity of nations. There are two distinct methods of helping toward this happy goal. One of these follows what we may call commercial lines, and the other (not necessarily antagonistic) travels over the accepted routes of scientific research.

The former plan may be likened to putting all the best goods into the window, and, having attracted the customers, to see that they purchase something. The other method is to give as much attention to the less valuable assets as to the most attractive, in the full belief that thorough knowledge will pay best in the end. The only antagonism arises when the exponent of the former method complains that the scientist spoils his chances by a too-open discussion of disabilities which were better discreetly hidden!

However, there is much less of this false patriotism nowadays. The authorities are encouraging the investigation of the physical controls which govern conditions in our less populous areas, believing that only by so doing can we make the best of our heritage. It is entirely with the object of helping this good work that the following article is written—for, to continue our parable, nothing can be such a bad advertisement as a misled or discontented purchaser.

One may misquote a well-known saying—"They little know of this lone land, who only this land know"; and we can only hope to arrive at the possibilities of Australia and can only estimate its resources by comparing them with similar assets in other countries. Isolation has its advantages in some respects. The "tight little island" no doubt kept free from medieval wars, but its marvellous progress was chiefly due to its natural resources in climate and coal. Here in Australia isolation is also advantageous in times of trouble, but in times of peace it tends to react adversely on the national character, fostering, perhaps, too optimistic a trust in Nature's endowment of the continent.

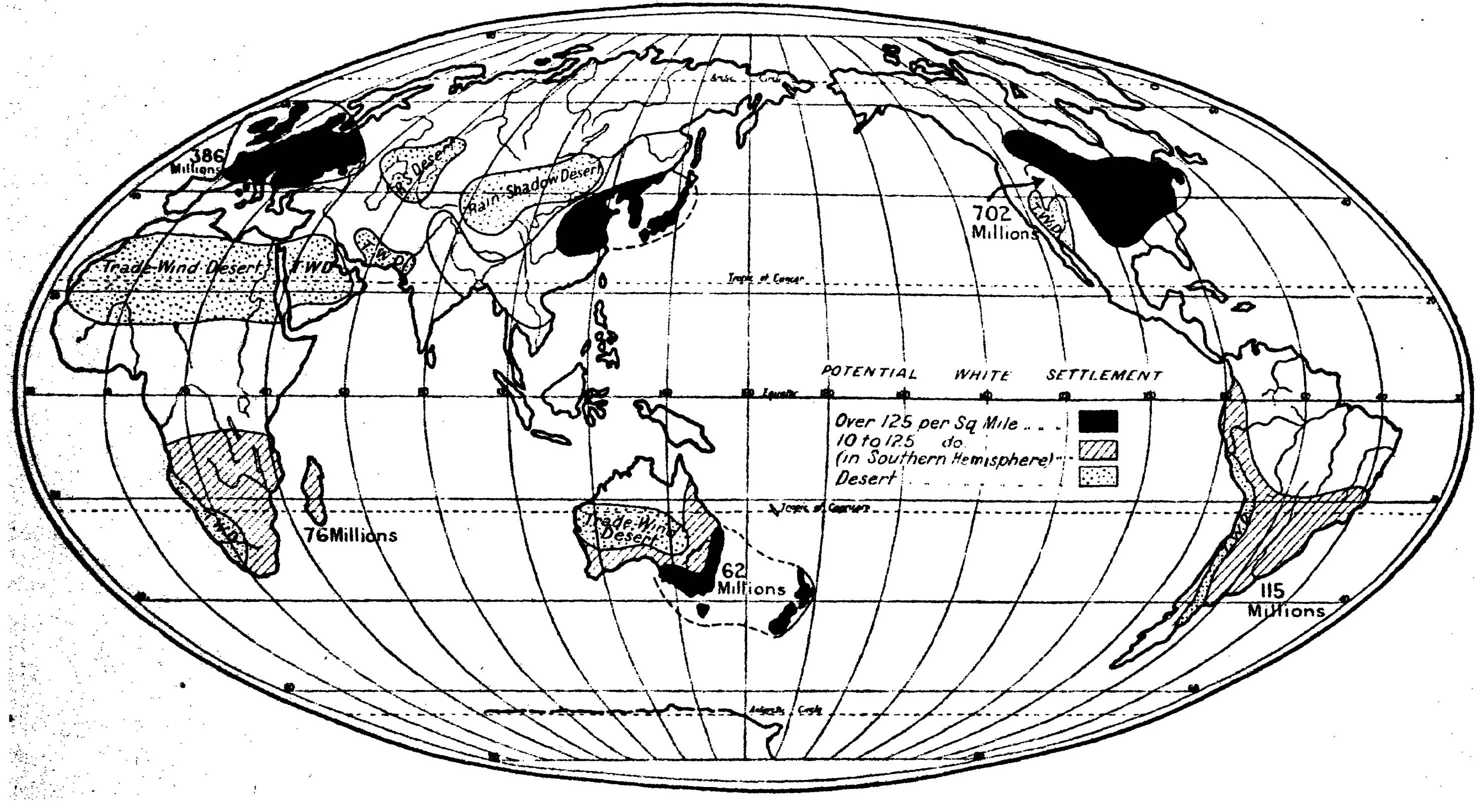
This article will therefore be largely concerned with comparisons based on recent physiographic research, and we shall find that we have reason to be proud of the future of Australia, even though it is not so well endowed as the older centres of white settlement.

Australia is particularly well suited for climatic studies, since it has the least diverse topography of all the continents and the most uniform outline. Hence it is free from variations due to elevated plateaux, high ranges, or deep gulfs and inland seas.

Unfortunately, these very characteristics are a distinct handicap as a dwelling place for man, and we may well devote some time to a consideration of how such physical controls affect Australia.

If we glance at a world-map representing either population, or vegetation, or rainfall, we shall find that the most striking feature in all three maps is the belt of empty arid lands which lies along the

FIG. A.—THE STATUS OF AUSTRALIA AMONG THE CONTINENTS.
(Only potential WHITE Settlement is considered.)



tropics in both hemispheres. (See Fig. A.) These are the regions where the trade winds are supreme; and where they blow from the continents to the ocean they are desiccating winds. Their realm covers half the surface of the globe, and where a broad belt of land is affected (as in Australia and Northern Africa) the result from an economic point of view is well-nigh disastrous.

Here, then, is the first and the chief burden which Nature has laid on the Australian. Nothing can make up for the large extent of our continent which lies below the constant sweep of the desiccating trade winds. It is no help to know that in fairly late geological times the continent extended into more clement regions to the south and east where the climate was undoubtedly better suited for closer settlement.

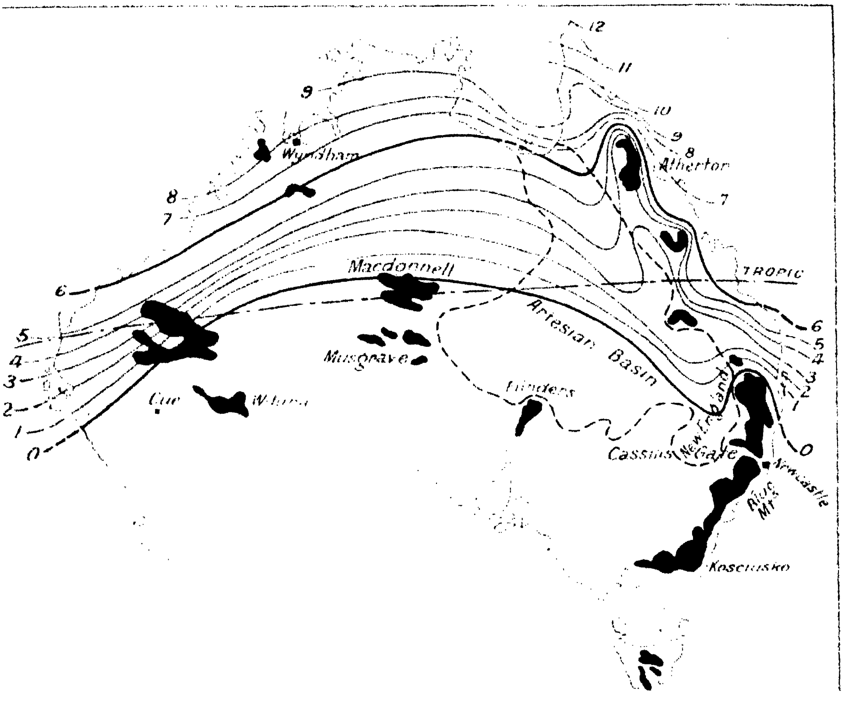


FIG. B.

The figures show the number of months with an average wet bulb over 70° F. The black areas are over 2,000 feet above sea-level.

In Cretaceous times our land probably extended from Adelaide to Macquarie Island and New Zealand. Moreover the trade wind belt was interrupted by a great sea (extending from the Bight to New Guinea), in which were deposited our well-known artesian water-bearing strata. At this date the Western Australian interior (now a desert)* was almost certainly visited by constant rain-bearing winds, and the

* Desert in the geographical sense is country receiving less than 10 inches of rainfall, and at best capable only of sparse pastoral occupation.

vegetation was correspondingly luxurious. Possibly the eighty palms which occur in Palm Valley in Central Australia are the last descendants of this luxurious flora.* We must go 500 miles away across barren sandridge country to the north to find another specimen.

There is, of course, some compensation in the well-watered east coast for the barren interior and west. Queensland owes much of her prosperity to the constant south-easters, which give her the heaviest rainfall in the continent. Hereabouts they blow from sea to land, and impinging on the elevated coastlands, they deposit as much as 14 feet of water per annum in the Cairns district.

There is little doubt, however, that a site some ten geographical degrees to the south of our present position would have made Australia a rival of the United States of America, whereas her natural assets cannot compare with that country. Our latitude is, therefore, a severe handicap.

We may now consider the topography in some detail. Here also it must be admitted that most large land areas are better served by Nature. In temperate lands large areas of lowland are the most suitable for white settlement, while in the tropics plateaux are much to be desired, as far as the comfort and health of the white race is concerned.

Large areas of tropical America (North and South), of Asia, and of Southern Africa consist of highlands over 2,000 feet above sea level. Only in Northern Africa and Australia has Nature been niggardly. It is an instructive parallel to compare Rhodesia with tropical Australia (which is a little over double its area). About 90 per cent. of Rhodesia is a plateau with a correspondingly cool climate. Only 4 per cent. of tropical Australia is so favoured. (See Fig. B.)

In the Atherton plateau, in North Queensland, we have a most valuable tract of country, where farming and dairying are already being extensively carried on. It is situated within 18 degrees of the Equator, and an area of some 12,000 square miles is 2,000 feet above the sea. No doubt electric power will be developed on the eastern flank of the plateau, which dips steeply into the Pacific, and is watered by many small rivers.

But it stands almost alone. On the tropic is the Macdonnell Range region. This, however, is in the centre of the trade wind area, and the rainfall is too low for a heavy population, although the climate is excellent for the greater part of the year. In the Kimberley region, in Western Australia, is another small plateau, and near the Fortescue River (on the tropic also) are some highlands. Temperature and rainfall conditions are somewhat adverse in both these regions, and they can never approach the Atherton plateau as a nucleus of white settlement in the tropics.

It is often stated that a high range, resembling the Andes, in the heart of the continent would save our interior. This is improbable. If we look at similar latitudes in South America we see that the flanks of the Andes where they cross the tropic have a rainfall below 10 inches,

* Probably in Pliocene times this region was much better watered. (See "Climatic Cycles," in Bibliography.)

although they tower 25,000 feet above the sea. If the atmospheric currents contain no moisture, it matters nothing if the mountains deflect them high up into cooler regions—no rainfall can be condensed.

In our temperate areas it would doubtless be an advantage if the highlands were disposed at some considerable distance from the sea in place of being elevated along the actual margin of the continent from Cooktown to the Victorian Grampians. We should then have many "Yarra" and "Hawkesbury" rivers—perhaps rivalling the Murray in size. They would be fed by numerous tributaries and bordered by fertile plains. Under present conditions our largest rivers resemble the Nile, their lower courses being situated in much more arid country than the headwaters. Thus the Diamantina, Barcoo, and Paroo rarely reach their outlets. The Warrego, Darling, and Lachlan often cease running, while the Murray occasionally dries up as it traverses the low-land belt, which receives only 10 inches or so of rain per annum.

However, all this country is favoured by its geological structure. Given a region with insufficient rainfall, it is obviously an enormous asset if a subterranean supply can be tapped. In the eastern half of Australia Nature has compensated for her disposition of the highlands by placing a series of permeable sediments (at various depths to 5,000 feet below the surface), in which a considerable proportion of the rain is collected. The origin of the artesian water is still a vexed one, but the balance of opinion certainly favours present rainfall, and possibly Pleistocene ground-water rather than "plutonic" sources. There are also several other small artesian basins, but they do not compare in importance with the Queensland basin. (See Fig. B.)

Warping in fairly recent geological time has built up the main divide in Queensland and New South Wales. The upturned edges of the mesozoic sediments are supposed to catch the rain in the better watered areas, and carry it slowly to the north, west, and south-west. Some of it bubbles up naturally in the mound springs near Lake Eyre on its western boundary. In Queensland alone there are 2,000 artesian bores, and there are also many in north-west New South Wales and in the north-east corner of South Australia.

Unfortunately, there is little hope of this water amounting to more than is required for stock. It is doubtful if it can ever be used for agriculture. It is folly to state (as in a recent imposing publication), "As 22,000 square miles of Algeria have been reclaimed by artesian water, there is no part of Australia in which cultivation may not become ultimately possible." The truth is (unless we get settlers of the Indian ryot class) that there is little hope of any cultivation of importance based on this supply. On the other hand, the prosperity of the pastoralists in Western Queensland is largely due to this form of Nature's bounty. Unfortunately, the supply is certainly diminishing.

Some readers may be surprised that so little mention is made of irrigation. While this may lead to the settlement of many thousands in favoured localities, it can make no practical difference to the general character of a continental surface. There are about 1,000,000 square miles in Australia receiving less than 10 inches per annum. In Victoria there are about 600 square miles of irrigated lands; in New South Wales about 400, and quite negligible areas elsewhere. Hence, with

the choicest sites occupied (though not necessarily half of those available), only about *one part* in *a thousand* of the lands needing irrigation has been benefited.

One other aspect of the topography merits some attention. All our important highlands are collected along the eastern and south-eastern coasts. They are probably largely due to wrinkles in the earth's crust, formed by pressure directed against the Western Australian massif. (We see certain drowned "wrinkles" of similar origin in the festoons of islands—Solomons, New Hebrides, Tonga, New Zealand, &c.—which border our eastern seas.)

Hence our main mountain valleys are usually disposed along a north-south axis, and they obviously lie in just the wrong direction for facilitating access to the east coast. The rivers have a tendency to flow in meridional lines, as in the Snowy, upper Murrumbidgee, Tumut, upper Lachlan, Shoalhaven, Nepean, upper Clarence, Dawson, Burdekin, &c., and this disposition of the "grain" of the country has necessitated very difficult railway grades just in the most populous part of our country. For years it absolutely prevented the construction of coastal railways, which are only now creeping slowly from port to port.

From the Darling Downs, in Queensland, to Kilmore, in Victoria, there is only one natural gap in the highlands below 2,000 feet (at Cassilis, behind Newcastle). This is a distance of 800 miles, and it is extraordinary that no railway has yet taken advantage of this low grade, which leads directly from our chief coalfield to the interior. (See Fig. B.)

Per contra, the coral polyp has taken advantage of the warping shore line of Queensland, and has built up a battlement of coral reefs for 1,000 miles in the same north and south direction. This insures one of the calmest sea routes in the world, though possibly the sea-captains could dispense with the placid seas if they were free from the dangerous and ever-growing reefs!

Let us now glance briefly at the climatic controls which affect the development of Australia. We are concerned primarily with temperature and rainfall, but we shall find that the humidity is of great importance in connexion with tropical settlement.

Since the southern hemisphere consists so largely of water, it is natural that on the whole it should have a cooler temperature than the northern. But where large masses of land are involved this difference practically vanishes. Tropical seas have a temperature of 80 degrees F. fairly generally, and the effect of a large ocean does not extend indefinitely inland. If we consider actual temperature records we find that four regions in the world exceed an annual average temperature of 84 degrees F. These are around Timbuktu, Massowah (on the Red Sea), Tinnevelli (at the southern tip of India), and Wyndham, in north-west Australia. The two former are arid. The two latter are very wet in the hot months. Hence Wyndham (with 84.6 degrees F.) is undoubtedly one of the least favoured regions in the world so far as temperature is concerned.

The "heat equator" must be drawn through Wyndham, Darwin, and Thursday Island, for these places are much hotter than any to the north or south. We are unable, therefore, to say that tropical Australia is cooler than other similarly placed regions, with the possible exception of North Africa. (The current temperature maps have fostered the error by recording temperature reduced to sea-level instead of the actual temperatures of the places concerned. Consider what this means for regions like Mexico.)

Heat as such is not of paramount importance, provided it be dry heat. In this respect Australia is fortunate in her arid interior, for the humidity is never very high except in the coastlands. Throughout

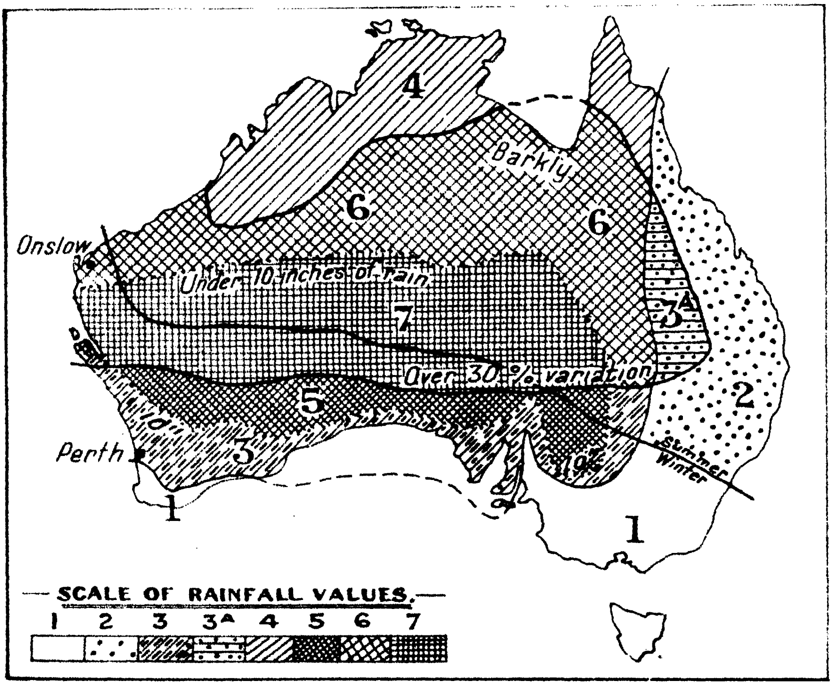


FIG. C.

Economic regions of Australia based on variations in the amount, season, uniformity, and reliability of the Rainfall. (For regions see Text.)

the summer months only the region north of a line through Broome, Daly Waters, and Rockhampton has a high humidity. It is very hot inland, certainly, with many days in succession over 90 degrees. The human organism can bear this without much discomfort or loss of health, provided the air be dry—but it is otherwise with plant life. Hence, from a hygienic point of view, a low rainfall is desirable in our tropics, but from an economic point of view this is disastrous.

We shall do well to consider the incidence of the rainfall at this stage, for this element is the controlling factor over almost the whole

of our continent. Every one knows that our fertile areas are disposed like a green garland around the arid interior. The wreath is broken on the west coast, where the out-flowing trade winds have dried a belt from Shark Bay to North-west Cape. It is very narrow along the Bight, and appears to be very broad along our northern coasts; and, of course, the belt of pasture and forests is best developed down the eastern coast.

If we watch how the rain belts vary from month to month we find that they march south with the sun. In mid-summer the northern belt (fed by tropical low-pressure systems) extends to Alice Springs. In winter the southern belt (controlled partly by Antarctic systems) moves north to Port Augusta, or farther. (See Fig. C.)

Hence there is a drought in the north during the colder months, and a drought in the south during the warmer months. This distinction is perhaps more important than the season of the rain, as we shall see later.

In the centre and west centre the rainfall is very low, and is due to erratic thunderstorms. In the east special coastal storms favour the littoral at most times of the year, especially in autumn; and in Queensland, as we have seen, the trade wind brings rain almost all the year round.

Hence our chief rainfall regions are four in number:—The uniform rain in the east and south-east; the winter drought region in the north; the summer drought region in the south and south-west; the arid region in the centre and central west coast. All our primary industries—other than those of mining—are determined by these conditions, but one further feature remains to be discussed.

It is a truism that if the rainfall were only reliable it would not matter so much if it were comparatively small in amount. By long experience farmers have learnt that in the Western Australian wheat belt a lower rainfall will suffice than in western New South Wales. Now that our records are fairly complete in many parts of the Commonwealth it is possible to study this aspect scientifically.

Consider the following table, where the same months in *consecutive* years have been taken at the places named.

UNRELIABLE RAINFALL.

Onslow (Western Australia) ..	**April, 1900 .. 11·0″** **„ 1901 .. 0** **(April Average, 0·9″)**	**May, 1900 .. 10·5″** **„ 1901 .. 0·5″** **(May Average, 1·5″)**
Borroloola (Northern Territory)..	**March, 1899.. 29·0″** **„ 1900 .. 0·5″** **(March Average, 6·0″)**	**Feb., 1896 .. 21·4″** **„ 1897 .. 4·7″** **(Feb. Average, 7·4″)**
Charlotte Waters (South Australia)	**March, 1908 .. 5·0″** **„ 1909 .. 0** **(March Average, 0·7″)**	**Jan., 1877 .. 9·7″** **„ 1878 .. 0** **(Jan. Average, 0·8″)**

One often hears that agriculture may be found profitable in the interior where the *average rainfall* is 10 inches, because wheat can be grown with such a rainfall in the Mallee or in the northern region of Western Australia. As a matter of fact, none of the Mallee is below 10 inches—and I have never been able to find a region in Western Australia below 10 inches where wheat is grown at all regularly.

If the rainfall at the right season exceeds 11 or 12 inches, and is *reliable*, well and good. But, as I shall now proceed to show, the greater part of arid Australia is cursed, not only by a low rainfall, but by a very uncertain one. By a method of reckoning, which I have explained elsewhere,* I have drawn up the reliability isopleth† shown in Fig. C.

The most variable region in Australia is around Onslow (W.A.). The best is around Perth, in the same State. The reason for the success in wheat in the south-west corner (Swanland) is shown at a glance. All the arid country (under 10 inches per year), except in Swanland and along the Trans-Australian Railway, has a variability exceeding 20 per cent. of its average total. Moreover, a great deal of the country, with better rainfall—especially to the south of the Gulf of Carpentaria—has also a very erratic rainfall. Thus the Barkly Tableland seems to be a very unpromising agricultural region, in spite of its average of 15 or 20 inches a year.

As regards future prospects of settlement as based on rainfall, we may subdivide Australia into seven regions. In the following table the regions are arranged approximately in order of value. (See Fig. C.)

Class.	Sub-class.	Chief Localities.
1. Uniform	With winter maximum ..	Riverina, Victoria, Tasmania
2. "	With summer maximum ..	Eastern Queensland, north-east of New South Wales
3. Seasonal, but reliable ..	Moderate winter rain ..	"Swanland" (Western Australia)
4. " " ..	Summer rain	Kimberley and Northern Territory
5. " " ..	Arid winter rain ..	Coolgardie to Broken Hill
6. Erratic	Summer only	Pilbarra, Macdonnells
7. "	Arid only	Central Australia

Our agricultural and pastoral production can be classified in terms of these regions. Thus all the important timber areas are confined to

* See Fig. 125 in *Australian Meteorology*, 1920. (Oxford University Press.)

† *Isopleth*, a term akin to contour; *i.e.*, a line through localities experiencing the same conditions.

the uniform belts. Here are the soft woods of the Queensland coast—the hardwoods of the south-east and of the south-west. Contrary to existing vegetation maps, there are no tropical rain forests of any value along the north coast, for the long winter drought prohibits their growth.

The farming and close white settlement area is also confined practically to regions 1, 2, and 3. Sheep are found chiefly in 1, 2, 3, and 5, though a few (perhaps 2 per cent.) occur in 4 and 7.

Cattle will do well in rougher, hotter country than sheep, and so predominate in 4, and are fairly abundant in 6. Dairy herds, of course, exist throughout 1, 2, and 3. I have worked out the climatic controls for cattle, sheep, and wheat very fully in Meteorological Bulletin No. 11, Melbourne, 1916, which is illustrated by 18 maps in colour.

A very important asset is the mining industry. Remembering the settlements at Kalgoorlie, Broken Hill, and elsewhere, one is apt to attach, perhaps, too much importance to mining as a means of settlement. It has been calculated that only about 120,000 people are settled in mining regions which would otherwise hardly be inhabited. Many of our mines are in good pastoral and agricultural land, where it is difficult to say what would have occurred if the mines had not been discovered. However, there is no doubt whatever as to the value of the early gold mines of Broken Hill, of Mount Morgan, Kalgoorlie, and the West Tasmanian mines in attracting settlers to Australia. The population graph shows very clearly a direct response from abroad; and, of course, much of this wealth is used to develop many other phases of activity.

The mineral wealth does not lend itself to generalizations so readily as do the climatic controls. One may, however, point out that the geological map naturally gives a very good clue to future mineral regions. For instance, many people fancy that the unknown arid interior is very likely to produce another goldfield region, like that extending from Southern Cross to Laverton and Cue in Western Australia. This is distinctly unlikely, for there seems to be a great change in the geological structure a little north of the Cue-Wiluna line. (See Fig. B.) The strata are much less disturbed, and probably much newer. In fact, we can say safely that no such widespread field can possibly be discovered, though smaller fields and valuable mines will doubtless be opened up from time to time.

All the lowland country from the Gulf of Carpentaria to the mouth of the Murray is also too recent and undisturbed for mineral solutions to have penetrated it. However, no one can say that Nature has been niggardly in her store of mineral deposits in Australia.

The chief interest to the economist, perhaps, lies in the coalfields. The surpassing wealth of the United States of America, of Britain, and of Germany is almost wholly due to their stores of buried energy. The much-talked-of "decline" of France is due to her meagre supplies of industrial fuel. Lack of coal has hampered her industries—whereas all

the great white populations have developed on the coalfields. (See the most valuable article by "Politicus" in the *Fortnightly Review* for February, 1918.)

Since this is the most convertible of Nature's gifts to man, I have tabulated the world's chief sources of supply. (From the Geological Congress Reports on the Coal Resources of the World.)

	Tons of coal x 10^9	
1. U.S.A.	3,838	The great coal countries.
2. Canada	1,234	
3. China	995	
4. Germany	423	Important coal countries.
5. Britain	189	
6. Siberia	173	
7. Australia	165	
	7,017	

The world's available supply is said to be about 8,000 x 10^9 tons, so that these seven countries control practically the whole amount. India (79), Russia (60), South Africa (56), Colombia (27), France (17), and Belgium (11) obviously follow a long way behind.

It is gratifying to see that Australia ranks fairly high in the list. Her fields are all distributed along a belt from Hobart to Townsville; but the chief settlement will always be around Sydney, Morwell, Brisbane, and in the Fitzroy basin. As we have seen, this is the best favoured region as far as climate is concerned, so that Nature herself seems disposed to bring about more and more centralization.

One problem to which much attention has been given still remains to be discussed. This is the probable trend of settlement in our tropics. Obviously the most logical method is to find what foreign regions will compare with our regions, and to see what experience teaches in those regions.

While bare climatological data do not completely define the environment of a locality, still they give valuable clues. I have published elsewhere a table showing that Broome is a homoclime (similar climate) of Banana at the mouth of the Congo.* Carnarvon and Wiluna resemble German South-west Africa. Darwin is like Cuttack, on the east coast of India, Townsville is like Calcutta or Rio, and Wyndham like Tinnevelli, at the tip of the Peninsula of India.

These parallels must give any one pause who wishes to settle white women and children on our northern tropical coasts. The matter is not fully investigated, and it is quite possible that the wind factor (which is rarely recorded in suitable form) may have an ameliorating effect on the human organism. We have, however, no valid reason for believing our winds to be more beneficial than the winds of these other tropical localities.

An appeal to the readings of the wet bulb thermometer (which were long ago installed by the Commonwealth Meteorologist) gives no more favorable results. If we assume that an average monthly reading of

* *Australian Meteorology*, 1920. Oxford University. (229 illus.)

70 degrees wet bulb is the limit of comfortable living for white families, then the following table is not encouraging as regards our northern coast lands. (See Fig. B.)

SCALE OF DISCOMFORT, BASED ON AVERAGE WET BULB.

Based on the Graphical Study of Climate in Meteorological Bulletin No. 14.

	45°-55° F. most comfortable.	55°-65° occasionally uncomfortable	65°-75° often uncomfortable.	Over 75° F. almost continuously uncomfortable.
	Months.	Months.	Months.	Months.
Melbourne	6	6	0	0
Sydney	5	7	0	0
Hobart*	6	3	0	0
Coolgardie	7	5	0	0
Perth	5	7	0	0
Alice Springs	5	6	1	0
Brisbane	3	4	5	0
Townsville	0	3	9	0
Nullagine	0	5	7	0
Wyndham	0	3	3	6
Darwin	0	0	6	6
Thursday Island	0	0	6	6
Wellington (New Zealand) ..	8	4	0	0
London*	5	3	0	0
New York*	4	3	2	0
Batavia	0	0	10	2
Madras	0	0	6	6
Sierra Leone	0	0	0	12

* Some months below 45°; *i.e.*, cool, but comfortable.

However, in this, as in other controversial points, the last word is not yet said. But obviously our tropical problem is a climatological one, and it would seem obvious that money might well be spent on an investigation along these lines.

In no other portion of the world, so far as I am aware, is there a settlement of northern Europeans resembling our sugar-growers in the Cairns district. In Brazil, near Rio, are some Spanish and Portuguese—but they belong to a much warmer clime originally. All honour, therefore, to the Australians, who are very practically fighting Nature in their attack on the luxuriant wealth of the tropics.

I must not neglect to point out that we have been favoured with an almost complete absence of the worst tropical diseases. Malaria is certainly diminishing under adequate sanitary treatment. Yellow fever and beri-beri have never been of any great importance. These diseases have been the greatest enemies in other tropical regions, so that the paucity of our aboriginal population would seem to be a distinct advantage as lessening the risk from such contagious diseases.

I have now traversed rapidly most of the ground indicated by the title of the paper. In conclusion, it has seemed to me possible to make a first approximation to a map showing the *habitability* of the earth.

NATURE *VERSUS* THE AUSTRALIAN.

The study of future white settlement gives very definite conclusions as to the status of Australia. By dividing the world into 74 natural regions, each assessed quantitatively for (1) temperature, (2) rainfall, (3) coal, (4) location, it was possible to draw up a map which showed the areas of potential white population. Western Europe, Eastern North America, and North China (though this does not concern white folk) showed the highest figures—with considerable areas where over 200 people to the square mile would settle.

The United States is well entitled to call itself (in the material sense at least) "God's Own Country." The Japanese realize the value of Northern China, and hence they desire to obtain control of it. In the southern hemisphere, New Zealand and South-east Australia are the most favoured, being able, perhaps, to take ultimately 120 people to the square mile. There are, however, much larger areas of moderate habitability in South Africa and South America. (See Fig. A.)

Grouped in nations, we may show that the British Empire (when it is "saturated" to the extent of Europe to-day) may reach a potential white population of 377,000,000.

The following table gives my conclusions for a future date, which is by no means outside the province of present-day politics:—

TABLE INDICATING FUTURE WHITE SETTLEMENT.

	British Control.	U.S.A. Control.	Other States.	Total.
	Millions.	Millions.	Millions.	Millions.
1. North America	179	513	10	702
2. Europe	60	..	326	386
3. Argentine, &c.	..	..	115	115
4. South Africa	76	..	6	82
5. Australia and New Zealand ..	62	..	..	62
Total	377	513	457	1,347

It was not possible within the limits of this article to give much of the data on which my conclusions are based. Readers who are interested may consult the following books and memoirs by the writer:—

1. *Text-book of Australian Meteorology.* (229 illus.) 1920. Oxford University.
2. *Australian Physiography.* (3rd edition revised.) 1919. Oxford University.
3. *Climatic Control of Australian Production.* 1915. Meteorological Bulletin 11, Melbourne.
4. *Control of Settlement by Temperature, &c.* 1916. Meteorological Bulletin 14, Melbourne.
5. *The Australian Environment.* (180 illus.) 1918. Memoir 1, Commonwealth Institute of Science and Industry.*

* A fairly complete Bibliography of kindred literature appears at the end of the monograph.

6. *Settlement of Tropical Australia.* 1918. *Royal Geographical Society,* Brisbane.*

7. *Climatic Factors in Australia.* 1918. *Commonwealth Year-Book,* Melbourne.

8. *Physiographic Control of Exploration.* 1919. *Geographical Journal,* London.

9. *Climatic Cycles and Evolution.* 1919. *American Geographical Review,* New York.

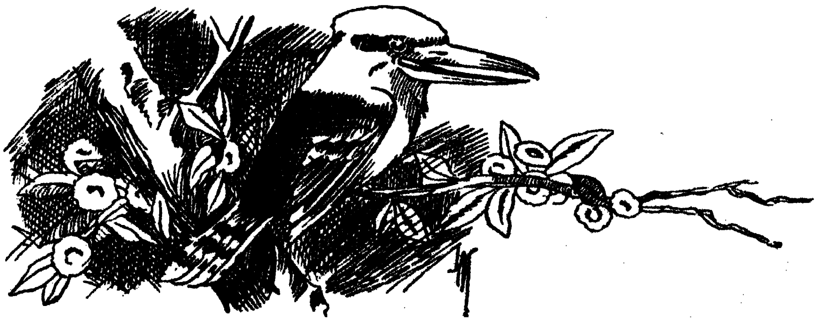
10. *Agricultural Meteorology of Australia.* 1920. *Quarterly Journal, Meteorological Society,* London.

11. *The Fringe of the Australian Desert.* (In the press.)

* Republished by the American Geographical Society, August, 1919.

Nothing great in science has ever been done by men, whatever their powers, in whom the divine afflatus of the truth-seeker was wanting.

—*HUXLEY.*



Beneficial *versus* Injurious Insects.

By **EWEN MACKINNON, B.A., B.Sc.**

Insects, though small in size, are capable of causing considerable damage and of producing much loss, but the enormity of the losses is not generally recognised. Their depredations are so varied, and yet so extensive, that all sections of the community directly experience their attacks at some time or other. Let figures speak. The United States of America estimates for the annual losses on animal and plant products average over 10 per cent. of the total value, and for 1915 are given as approximately £236,000,000; and for 1917, £260,000,000. On a similar estimate, the losses in Australia must have been in the vicinity of £18,000,000 in 1917, when the production was £183,000,000.

While the damage done by insects is admitted to be enormous, it must not be supposed that all insects are injurious. As a matter of fact, there are more insects that are either beneficial or non-injurious than there are injurious forms, and man owes much to the beneficial insects, especially those that render good service in keeping the injurious forms in check.

Beneficial insects have been broadly classed into five groups, as follows:—

(1) Insects that prey on or are parasitic upon injurious forms. Many examples are to be found in the ladybirds, ground beetles, hymenoptera, and diptera (flies). They are said to be entomophagous insects.

(2) Insects that pollinate flowers, *e.g.*, bees, ants, wasps, moths.

(3) Insects that feed on dead or decaying organic matter, hence called *Scavengers*.

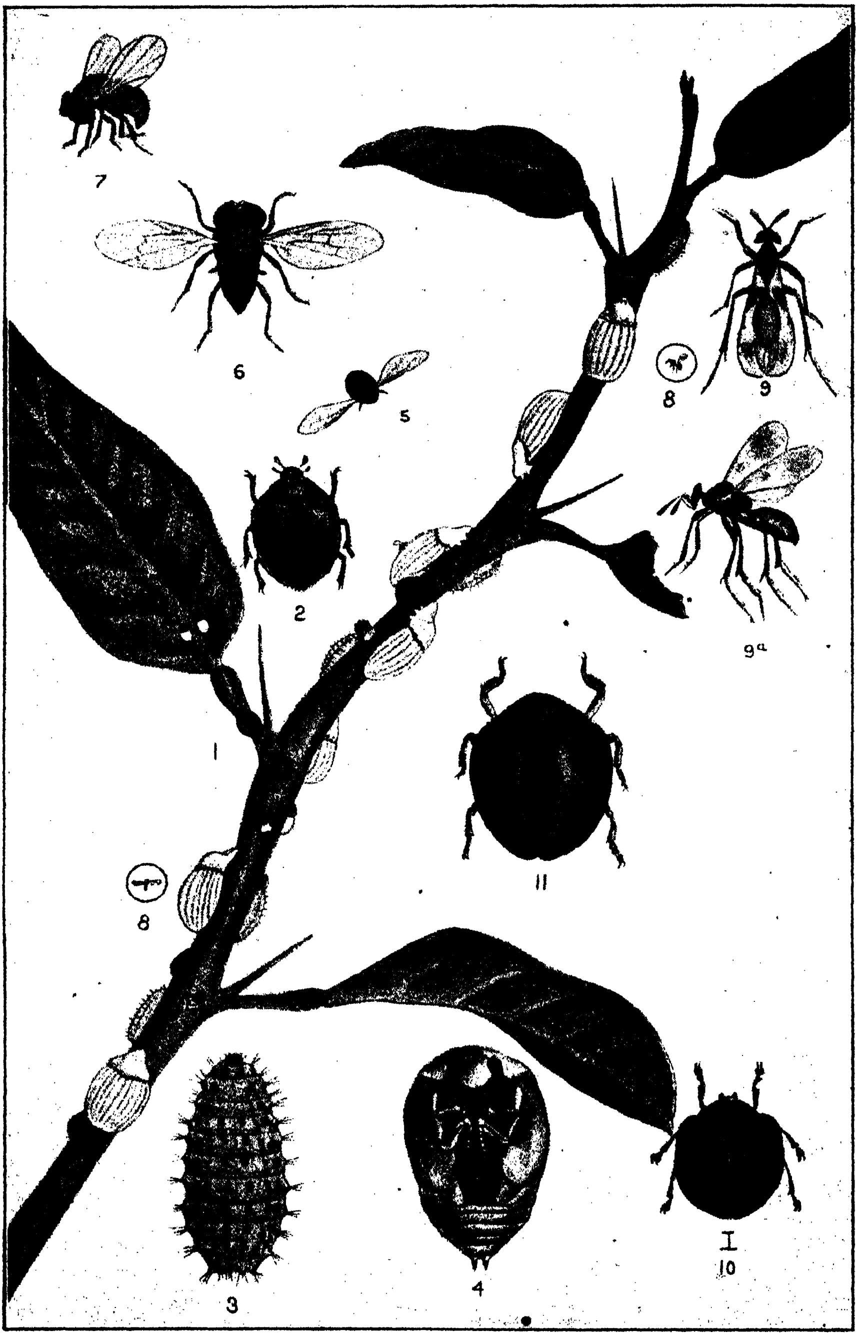
(4) Insects that serve as food for fish, birds, and other animal life.

(5) Insects that secrete or elaborate substances of commercial value to man, *e.g.*, the honeybee, lac insect, silkworm, cochineal insect.

It is the first group that interests us at the present time, though reference may be made to two things before dismissing the other groups.

(1) In connexion with the Sheep Blowfly problem, it has been suggested that greater use might be made of scavenger beetles. As the blowfly, and certain other flies that carry disease, breed in animal dung, it is possible that carrion beetles may help largely in the prevention of fly development by the destruction of much of the carrion—and incidentally destroy many fly eggs and larvæ—in which flies develop.

(2) The Germans have always been most expert in their application of science to industry. In their search for fats during the war, they were practically exploiting the blowfly. Millions of blowflies were induced to breed in fish waste. After the larvæ had reached a certain stage of development, they were used as a source of oil. As much as



1. Orange Branch with Cottony Cushion Scale (*Icerya*). 2. Ladybird (*Novius cardinalis*), and its larva. 3, 4, 5, 11. *Novius*: larva, pupa, perfect insect on wing, and magnified. 6, 7, 8. *Lestophonus iceryae*. 9, 9a. Hymenopterous parasite of scale. 10. *Novius bellus* destructive to scale. (*After French.*)

4½ per cent. by weight being obtained. Such a process may be distasteful to us, but when the oil is hydrogenated, its uses are greatly extended, and its source and nature will remain unrecognised. The blowfly must henceforth be included in group 5, in Germany, at least.

The method of employing one insect to control another was largely adopted by Decaux, in Picardy, in France, in 1881. He had observed great numbers of tiny flies emerging from the buds of apple trees attacked by the *Anthonomus* weevil (similar to the cotton boll weevil—*A. grandis*). He collected damaged buds, and preserved them in boxes covered with gauze. When the parasites hatched out they were liberated in an orchard—over a quarter of a million of parasites being thus set free. This was repeated in the following year, and served to free the orchard from weevil for about ten years. Berlese, in Italy, extended these methods in the fight against *Diaspis pentagona*, a scale insect, and one of the worst enemies of the mulberry in Italy.

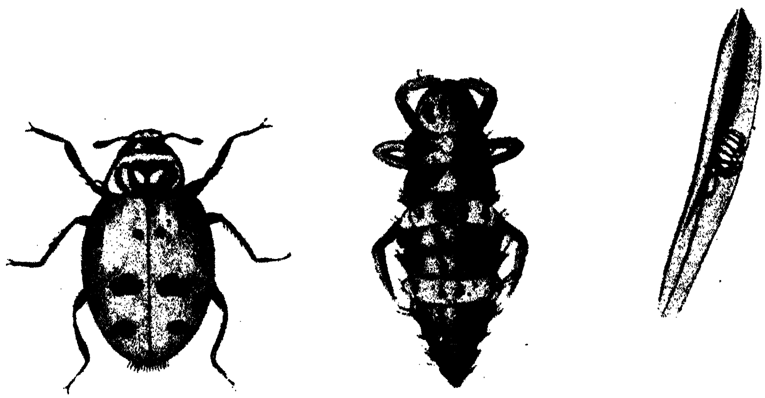
It has been in America, however, that this method of control has been adopted to the greatest extent

CARNIVOROUS BEETLES AND THEIR PREY.

1. *Carabus nemoralis;* 2. *Calosoma sycophanta;* 3. *Carabus auratus;* and 4. its larva.

About the beginning of this century, the San José Scale and the Cotton Boll Weevil threatened two important industries. As a result of the entomological investigations in these two problems, many advances were made in the methods of insect control, and considerable information gained concerning the relations of injurious insects to other organisms and to external factors. Paris Green had been adopted as a standard remedy against Colorado Potato Beetle, and kerosene emulsion had been developed against sucking insects. These remedies were followed by hydrocyanic acid gas and lime-sulphur wash, and many experiments were made with beneficial insects. In the last decade, in the attempts made to solve the problem of the control of the Gipsy Moth and Brown Tail Moth, both introductions from Europe, and the cause of widespread destruction of forest timber trees, important advances have been made towards a better understanding of parasitic insects, and of the part they are likely to play in the control of injurious

insects in the future. The biological method of fighting insects has been fully developed. This, broadly speak'ng, embraces the use of all natural organic checks—bacterial and fungous diseases, as well as parasitic and predaceous insects. Although fungous and bacterial diseases have been used to a slight extent, most of the work has been done with the entomophagous insects. These, according to their mode of attack, have been divided into predatory and parasitic (or endophagous). The former devour other insects or their eggs or larvæ. The parasitic insect enters the body, egg, larva, or pupa of its victim, and destroys it, or may remain for part or all of its existence on the surface. Parasitism is a condit'on which exists widely throughout the animal kingdom. Hunger and the quest for shelter have probably led to the habit of existing as unbidden guests. One insect, the parasite, lives in or on another—the host—securing the necessities of life from the host, wh'ch gives up part or all of its vital forces to the parasite. Very few species of insects are exempt from this unwilling entertainment of parasites. It often happens that the parasites them-

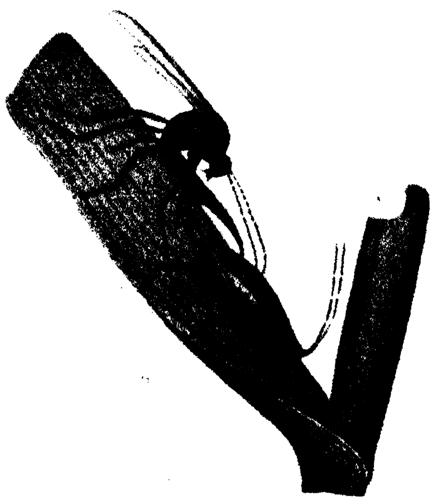


(a) (b) (c)

Hippodamia convergens, **a ladybug which devours the "green bug."** *a*, **adult;** *b*, **larva;** *c*, **cluster of eggs.** (*After Hunter.*)

selves are infested with other parasites, which we call secondary, which reduce very appreciably the effect'veness of the first or primary parasite. The secondary parasites, also termed hyperparasites, may be also parasitized. In the control of injurious insects, then, primary and tertiary parasites are beneficial, while secondary are harmful. Among insects are to be found all variations of parasitism. The external paras'te, such as the sheep tick or the bird louse, spends the whole of its existence upon the host. In the case of a Chalcid, such as *Nasonia brevicornis,* a parasite of the blowfly larva, the eggs are laid within the larva, where the chalcid will dwell until it emerges as a fully developed winged insect—it is an internal parasite for part of its existence. There are many advantages gained by the parasite, such as abundant food, safety, and warmth; but there may be certain disadvantages. The parasite tends to degenerate through the disuse of organs (disuse atrophy). The sheep tick was once a winged fly, but has

degenerated, or has suffered disuse atrophy, as its wings were no longer used, and consequently were less and less developed. Most of the parasites that are used in controlling insect pests show very little degeneration, being parasites for part of their life, and for the rest are extremely active independent insects. Parasites may be restricted in their parasitism to one stage in the development of their host, *i.e.*, they may parasitize the egg only, or the larva only, or may confine their attention to the pupa. A complete sequence of parasites is of greater efficiency than multiple parasitism. The introduction of predators and parasites which have counterparts in other places is of little value, while the introduction of new species which form a new element in the chain of sequence has always great possibilities. In the first case, the introduced insect merely replaces a portion of the individuals of the local species; while in the second case there is no replacement, and the effectiveness of the introduced species is added to the effectiveness of the species which already occur in the region, but are of different habits.



Spring Grain Aphis, *Lysiphlebus tritici*. Parasite on Green Bug, *Toxoptera graminum*. (*After Hunter.*)

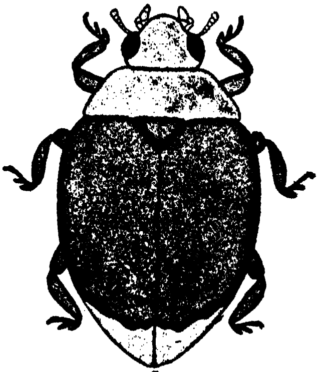
The economic use of entomophagous insects may show three phases:—

(1) The introduction from other countries of species which do not occur in the country infested with the insect it is desired to control.

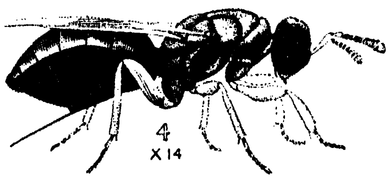
(2) The transportation of the parasites from one district to another.

(3) The utilization of native species already parasitic or predatory in the district, increasing by artificial means the number of the individuals already present in such a way as to bring about a higher relative mortality in their host than would have occurred if left to act under normal conditions. This involves an attempt to make the entomophagous insects continually dominate their hosts, a condition which will not exist if natural conditions are allowed to prevail. Control by this method has to take account of the fluctuations of hosts and parasites. The balance of nature is like a pendulum swinging to and

fro, the dominance of any particular species of insect pest alternating with the dominance of its natural controls. The development of insects is largely dependent on food supply, though they are very sensitive to the influences of environmental stimuli, such as light, heat, moisture, chemical influence (odour), shade, wind, contact, &c. Though their capacity for reproduction is very efficient, and their powers of assimilation are prodigious, they fluctuate very much in numbers. When conditions are favorable, most insects will multiply rapidly. But they are as a house divided, one part preying upon and destroying the other, and the two often succeed each other like wave after wave of the ocean. Parasites finding innumerable insects to prey upon increase so rapidly that they kill off their own means of support. They in turn succumb, and the host rallies once more while the numbers of its opponents are few. It is at such times as these, when both host and parasite are reduced, that numbers of parasites, which have been bred in special insectaries for the purpose, are liberated, in order to prevent the host insect from once more gaining that ascendancy which, sooner or later, makes it a pest. The recovery of the host precedes that of the parasite, as the latter has to depend on the host for its support. Hence



Adult female of *Cryptolaemus montrouzieri* Muls. (Essig. P. C. Jr. Ent.)



***Nasonia brevicornis*.**

its development lags behind that of its host, and many may die from starvation. One of the best examples of control by this method is the Citrus Mealy Bug (*Pseudococcus citri*) in California. It is one of the most difficult pests to control, but in several orchards in southern California it has been brought under complete subjection by the continued liberation of large numbers of entomophagous insects, principally *Cryptolæmus montrouzieri*, a ladybird less than half the size of its host. This, like many other parasites now being used in America, is of special interest to Australia, as it has been recently at work in many parts of Australia, *e.g.*, at Manly (Sydney) on the Golden Mealy-Bug (*Pseudococcus aurilanatus*), which was destroying the great pine trees encircling the beach. *Cryptolæmus montrouzieri* has also been introduced into Hawaii with good results.

While Australia has been a fertile source for many useful parasites for other countries, very little has been done here to exploit this method

of insect control. We have records of many insects at work controlling injurious insects, but this is almost entirely the work of nature. The controlling hand of man has not taken part to any extent. The most important entomophagous insects belong mainly to the orders Hemiptera, Hymenoptera, Diptera, Neuroptera, and Coleoptera.

The Coleoptera include ladybirds (*Coccinellidæ*), murky ground beetles, and tiger beetles. The ladybirds feed upon small insects and the eggs of larger species, and are especially valuable for keeping down plant lice (aphids). Their larvæ also are quite active, and hunt for their prey. The ground beetles (*Carabidæ*) destroy large numbers of caterpillars of various kinds. They hide under stones and boards in the day time, but leave their shelters at night time seeking what they may devour.

The Hymenoptera include many important parasites belonging to the families known as the Ichneumonidæ, Braconidæ, and Chalcididæ, all very small wasps. Also included in this order are the smallest of all parasitic insects, the Proctotrypidæ. Their larvæ live within other insects, often in the eggs, and sometimes within the larvæ and pupæ. Sometimes they occur as secondary parasites, and as such have to be eliminated from the primary parasite before the latter can be employed.

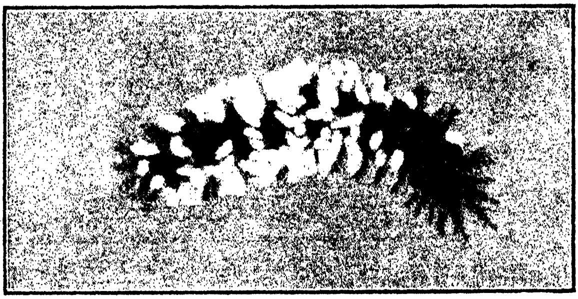
Caterpillar of Army Worm with Tachinid Eggs attached.

Several families of the Diptera are either parasitic or predatory. Two of the best known are the Tachinidæ and the Syrphidæ. The Tachinids are bristly flies, closely related to ordinary houseflies. They parasitize many kinds of caterpillars and grubs of large sawflies and immature grasshoppers. They attach their white eggs to the surface of caterpillars, especially cutworms (plant destroyers), with a gummy secretion. In other cases, they insert their eggs within the bodies of their victims, or deposit them on leaves which form the food of their hosts. The eggs are thus taken into the digestive system. They are a most useful group to the agriculturist. The Syrphids, or flower flies, are large, and often bee-like in form, and lay their eggs in colonies of plant lice, which are later on devoured by the larvæ that hatch out from the Syrphid eggs. These larvæ feed exclusively on aphids and plant lice.

The Hemiptera include many of the well known bugs (assassin, stink, damsel, ambush, and others), of which there are some beneficial forms, in addition to the many injurious ones.

The Neuroptera include forms known as aphis-lions or lace-winged flies, which are predatory on many plant lice.

There are many examples of the success of the biological methods of controlling insects, but only a comparatively few can be mentioned. One of the most notable, as well as one of the first triumphs achieved was that against the Cottony Cushion Scale (*Icerya purchasi*) or Fluted Scale of the orange. This scale is reputed to be a native of Australia, but is not a menace here, as it is held in check by natural enemies. It became established in New Zealand, South Africa, and California (1868). So formidable did it become in the last country by 1888, as the controlling parasites were absent, and conditions were very favorable for its rapid spread, that it threatened to ruin the citrus industry. All attempts to fight the scale with spraying and insecticides were in vain, and the growers appealed to the Entomology Divis'on of the Federal Agricultural Department. The Entomology Division and the State Board of Horticulture of California decided to co-operate and to send two entomologists to Australia to search for parasites, for the dipterous fly in part'cular. This parasite had been sent to Washington for examination, and had been named *Lestophonus iceryæ*, by which name it is known throughout California, although the more correct name is stated to be *Cryptochætum monophlebi* (Skuse). One of the



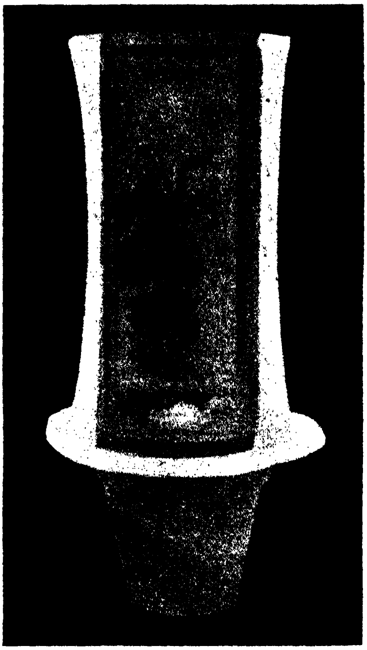
[Cal. M. Bul., Vol. II., Nos. 1 and 2.

(Hairy Caterpillar) Larva of Moth covered with Cocoons of an internal parasite.

entomologists (Koebele) was successful (1888) in sending many living specimens of this fly, and of a ladybird *Vedalia* (Novius) *cardinalis*, to California. The parasitized scales, received in the first instance from Mr. Crawford, were placed in cages enclosing orange trees in Los Angeles, and the parasites were seen to issue. Mr. Koebele was sent out to secure large quantities of the parasite, and he succeeded in supplying Mr. Coqu'llet, in Los Angeles, with 12,000 specimens, which were established in the open. *Novius cardinalis* was sent from California to Florida, Italy, Egypt, Syria, Portugal, Cape Colony, Hawaiian Islands, and New Zealand, and good results were obtained. Dr. Howard gives the following reasons for its success:—(1) Novius produces in one year double the number of generations that Icerya does; (2) Novius feeds preferably on the eggs of Icerya; (3) Novius was introduced free from its own parasites; (4) Novius is an active insect, while Icerya is fixed to a plant.

Some recent work of great interest to Australians was that carried out by the late E. J. Vosler, then Fore'gn Collector for the Insectary Division of the Californian State Commission of Horticulture. The

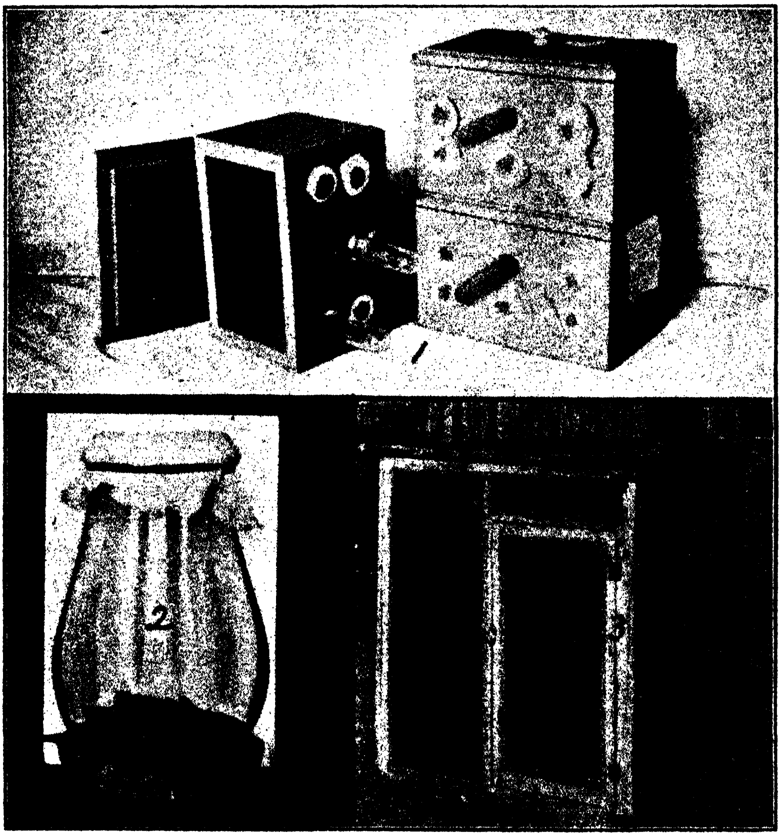
work consisted briefly of an examination of the leaf hoppers to be found on a number of *Chenopodiaceæ,* native or introduced, such as Salt Bushes (*Atriplex*), Goosefoot or Fat Hen, Russian Thistle, and various other weeds and grasses; a search for the larvæ that were parasitized; the collection of large numbers of hoppers and larvæ; the packing and despatch of the collections by steamer to California. It has been of great value to have had these investigations by Mr. Vosler, who visited all our State Agricultural Departments, and secured the active co-operation of all the entomological branches. The investigations became practically Federal in character. Co-operative projects like this should form part of the scheme of entomological research to be undertaken by the Institute of Science and Industry. The main outlines of Mr. Vosler's work has been published in *Science and Industry,* Vol. 2, No. 3, pp.184-189, so that only brief reference need be made. The Leafhopper



Cage used for rearing Beet Leafhopper.
(After Vosler.)

is a tiny insect of the family *Cicadellidæ* (or the Jassids), and not far removed from the Cicadas, and included in the same order Homoptera with the aphids and scale insects. A leafhopper was found on *Atriplex mulleri* near Sunshine, in Victoria, that was parasitized to the extent of 85 to 90 per cent. by two egg parasites, *Pterygogramma acuminata,* and a *Mymarid.* The former attacks several species of *Jassids* or leaf-hoppers, and the chances of its breeding successfully on the beet leaf-hopper in California were thought to be good. The leafhoppers have their mouth parts well developed for sucking the juice from plants, and one species, *Eutettix tenella,* has become a serious pest of the sugar-beet in California, being the chief means of distribution of the disease known as Curly Leaf of the Beet. The previous investigations in

Australia by Koebele and Webster had shown that we had many species of leafhoppers, and it was hoped that sufficient parasites might be obtained and introduced to California to bring under control the hopper *Eutettix*. Expectations have not yet been realized. There are many difficulties in introducing foreign insects. Firstly, the rearing of great numbers in captivity, providing suitable food, and transportation, often over long sea routes, call for much experimental work. Parasitized larvæ can generally be shipped under cool storage conditions.



1. Boxes used in breeding Cotton Boll Weevils and Parasites. 2. Breeding Jar used in life-history work. 3. Folding Cage used in field experiments. (U.S.A. Bur. of Entomology.)

In the new home, the insects have to be acclimatized, and again the food problem and environmental conditions must be carefully studied, *e.g.*, the work with mealy-bug parasites led to the development of the "potato sprout" method of rearing large numbers of mealy-bugs with which to test out the parasitic and predatory habits of the insects under investigation. Every kind of insect demands its own particular method of investigation. The investigator must be able to contrive simple but effective devices for the determination of the various factors. The tendency among the best workers is to use inexpensive appliances. The most important consideration in the rearing of insects for the purpose

of ascertaining their life history is to make conditions as near natural as possible. Cages of various kinds covered with muslin or wire mesh are in common use. Some may be flower pots in which the host plants are growing, covered with lamp chimneys, wire screens, or other arrangements. Other breeding cages may be of a large size used in the open, completely covering full-grown plants. In the study of underground forms, such as white grubs and wire worms, the cages are usually buried in the soil. The environmental conditions must be studied, *e.g.*, aphids readily succumb to heat, and the cages may be placed in shelters covered with a canvas screen, or they may be shaded by trees.

Other Australian parasites taken to California by the late Mr. Vosler were:—(1) A predaceous moth, *Thalpochares cocciphaga*, one of the most important of our enemies of the Black Scale (*Saissetia oleæ*). The larva of the moth feeds on all stages of the scale, but seems to prefer the eggs. From full-grown larvæ placed in cold storage seventeen moths were reared at the Insectary, and these have since been propagated through several generations. They have given great promise of being active predators of the Black Scale of Citrus in California.

(2) Internal parasites, *Aphycus lounsburyii* and *Coccophagus sp.*, on Black Scale appear to be successful.

(3) The egg parasite, *Scutellista cyanea*, a chalcid, was also found at work in New South Wales. This was first successfully introduced to United States of America from South Africa, in 1901.

(4) A parasite of a mealy-bug from an ornamental tree in Brisbane Botanic Gardens proved to be *Paraleptomastix abnormis*, the same as was brought from Sicily to California some years previously. There does not appear to be much doubt that the mealy-bug and its parasite were brought to Australia on imported material from Italy. The Citrus mealy-bug, *Pseudococcus citri*, has been a serious pest in United States of America, and parasites have been successfully introduced from Sicily, Japan, the Philippines, and Australia. A ladybird, *Midas pygmæus*, from Victoria, is breeding and feeding readily on citrus mealy-bug in California, and is considered a good addition.

The Australian gum-tree scale, *Eriococcus coriaceous*, spread with marvellous rapidity in New Zealand, right from its introduction, so that within five or six years the eucalyptus plantations of Canterbury and Otago were seriously infested. In Australia the scale is not so destructive, being held in check chiefly by the ladybird *Rhizobius ventralis*. In the bush, *R. ventralis* is quite common on young eucalypts attacked by Black Scale. Consignments of the beetle were taken to New Zealand and established within the affected areas. In a few years the scale was practically eliminated. It is largely grown in California to control the Black Scale, which there is one of the most serious pests on citrus and olive trees and many deciduous trees. Many species of parasites of the Black Scale were reared in California from material sent from South Africa. At least two primary parasites were reared, while many secondary parasites had to be eliminated. Both primaries emerge from the young scale before the eggs are laid, and hence filled a long-existing gap in the desired sequence of parasites. They became valuable additions to *Scutellista cyanea* and *Tomocera*, which attack the scale after the eggs are laid.

(*To be continued.*)

To Overcome Droughts:

A Plea for Science.

[The idea that Australia is cursed by Nature with relentless devastating droughts unfortunately still enjoys a wide belief. Is it that we are trying to accomplish the impossible or too often trying to accomplish the possible, but in the wrong way? These questions were asked by Mr. J. J. Fletcher, M.A., B.Sc., President of the Linnean Society of New South Wales, in the course of his presidential address. The following extracts from that address contains a good deal of matter for serious reflection.]

One of the events of the year has been the culmination of a disastrous drought; and though there has been relief in some districts, other localities are still much in need of rain. It has been a costly visitation to the State. The returns of the approximate number of live stock in New South Wales on 31st December, 1919, as compared with those of the corresponding period of 1918, show that there has been a decrease of 72,434 horses, partly due to very little breeding on account of low prices and small demand, and in part to the drought conditions experienced in may districts for the greater part of the year; of 399,378 cattle, attributable mainly to the effects of the drought, namely, to death from starvation, conditions not favorable to breeding, and the forwarding of cattle to market on account of the holdings not being able to carry large stock; and of 7.028,852 sheep, attributable almost wholly to the droughty conditions, which have been very severe on breeding-ewes, so that over the greater part of the State the lambing was a failure.*

In addition to the pecuniary loss represented by the depreciation of the State's flocks and herds by drought, it is necessary to take count of the fact that the Government is raising a loan of £1,000,000 by the issue of Treasury-bills bearing interest at the rate of 5½ per cent., with a currency of two years from 1st March, 1920, for the purpose of providing funds to finance advances to distressed farmers, and also to meet payments for seed-wheat purchased by the Government for issue to farmers, and for other purposes. The drought, therefore, has not only been another expensive intimation that Australia has still some lessons to learn about the solution of drought-problems, but that Australia has not learnt all there was to learn from previous similar experiences, particularly the drought which culminated in 1902, and was responsible, among other losses, for the reduction of the flocks of the State from 43,000,000 to about 20,000,000. "Prevention is better than cure," but as periodical droughts have a legitimate place in Nature's scheme of things in Australia, man cannot, therefore, prevent their occurrence. But is it impossible to learn how to mitigate, if not prevent, at any rate in some measure, the periodical levy on the wealth of the State by droughts? Why is it, for example, that it is left to droughts to cull the

* For further details see the *Sydney Morning Herald*, 26th February, 1920, p. 5, to which I am indebted for the particulars quoted.

flocks and herds in the exacting way in which it is done by every serious drought? Answers to these or other cognate questions are not hard to find. What Australia especially needs to learn is how to cope successfully with drought-problems; and to learn that it is necessary to understand and take to heart that droughts are teachers, and not a curse, since they are a legitimate factor in Nature's scheme of things in this quarter of the globe. Rabbits and prickly pear, &c., may be curses, but Nature is not responsible in any way for their foothold in Australia.

A recent writer has diagnosed the state of Britain, before her eyes were opened by the war, in the following words*—"We have sloughed our besetting sins in many mental processes. Before the war, men of science were grossly academic and individual; often abstract to the point of perverted mysticism; and the line they took encouraged the men of commerce to the contempt of pure knowledge. Men of science, merchants, the banks, and the Government were all in watertight compartments, working apart, and more than this, contemning one another. The result was that, from the nation's point of view, the brains of the chemist were wasted, the activities of the merchants handicapped, the wealth of the banks locked up, and politicians a vain luxury. The British brain was working; but was a milch-cow for other astuter nations." What is here said or implied about the importance of the co-operation of men of science with commercial men and with Governments, and about the national lack of the appreciation and practice of it, before the war, is only too true. But the men of science are not, equally with others, to blame for it. For, from time to time, their representative spokesmen have pointed out what was needed, but their warnings and their recommendations have too often failed to arouse attention or elicit any response. Or, if noticed, their views have been dubbed "counsels of perfection," or "arm-chair" advice, which the "practical" man can well afford to ridicule, or neglect altogether.

Now, in the case of Australia, there is great need for a closer and more effective co-operation of Science with the primary producer, the man on the land. With the manufacturer also, but in this case, the need can be easily provided for, since all he has to do is to make the necessary provision for increasing his staff by the addition of such scientific experts, chemists, or whatever they may be, as circumstances require. But the case of the primary producer is different, and it requires the most earnest consideration. It is necessary for him to learn and understand, what he is apt to overlook, or fail to realize the importance of—small blame to him, under the circumstances which have encouraged it—that there is a theoretical side to his practical activities which needs to be taken into account; that in his case, as in others, the theoretical side and the practical side are complementary, since true theories are merely the generalizations upon which practice is to proceed. Now a lack of appreciation of this need of the recognition of the complementary relations of science and practice in relation to drought-problems is plainly in evidence in books and in newspaper records; and I shall refer to some of them presently.

* Thomas, W. B., "A Better England—Not a Worse," *Nineteenth Century*, No. 514, December, 1919, p. 1018.

One imperative reason for taking account of them henceforth is what is implied in the statement that "Australia's bid for greatness rests upon her agricultural possibilities";* and that considerable progress has been made in this direction since these words were recorded, with more to follow in the immediate future. The imperativeness of the reason referred to arises in this way. In the earliest days of settlement in the inland district, the man on the land was a pastoralist solely. But now that he is devoting more and more attention to agriculture, it is necessary to remember that this means a steadily increasing removal of the natural covering of the soil—in the shape of forest, or scrub, or grasses, or whatever it may be—and that his operations necessitate, over a steadily increasing area, a profound disturbance of the soil-organisms and of their relations to the indigenous plants, which have come about as the result of Nature's long-standing arrangements. Now these are matters which cannot be treated with absolute indifference, for they mean much; and what they may do or mean it is necessary to learn.

Nature has adopted two ways of resting and sweetening the land, and, at the same time, of generally clearing up and putting things in order, getting rid of weaklings and undesirables, and putting species that have got out of bounds back into their proper places. These are, (1) annually recurring, hard winters, as in the extra-tropical countries of the Northern Hemisphere, the hardness varying with the latitude. This may be distinguished as the winter-sleep or resting of the land. And (2) periodical droughts in the sub-tropical countries of the Southern Hemisphere, like Australia, Sub-tropical South America, and South Africa, which have mild winters, not severe enough to give the land a thorough rest or sweetening. The arrears accumulate until, sooner or later, the drought comes, puts things straight again, strikes a balance, and makes way for a new start, the onset of the bumper year. This may be distinguished as the drought-sleep, or resting, or sweetening of the land. The difference between Nature's two methods of doing the same king of thing depends on geographical position, and on cosmical conditions of high and low pressure areas, sun-spots perhaps, and so on; and, of these, the meteorologist and the astronomer can give a scientific account.

Therefore, to rail at droughts, to call them a curse, to speak of them as responsible for a relentless, cruel environment for the man who goes on the land in Australia, or as a demon who robs the squatter of his hard-earned wealth, some of it earned simply by allowing Nature to convert grass—her own grass—into wool and mutton, is to be as ignorantly foolish as to say night, the need of sleep and recreation, the Sabbath-day's rest, and holidays are curses, unfriendly demons, because they nightly, weekly, or periodically interrupt his money-making activities. And it might be supplemented by lamenting that man is such an imperfect creature, because a perfect man should have an iron constitution, which would enable him to dispense with sleep and rest, so that he might uninterruptedly be making money, twenty-four hours per diem, seven days per week, 365 days per annum, year in and year out. That would be the way to make money!

*Gullett, H. S., "Australia's Development: the Coming of the Farmer," *Chambers' Journal*, January, 1909.

TO OVERCOME DROUGHTS.

The man on the land in the Northern Hemisphere, after generations of experience, has learned his lesson, and is able to live in harmony with his environment. The severity of the annually recurring winters compels him to house and feed his stock; therefore, he must grow enough fodder to provide for them, and he must cull his flocks and herds, so that the demand for fodder shall not exceed the supply. What helps him to learn his lesson is, that the recurrence of winter conditions, on the whole, is so regular, that he can arrange his programme of work by the almanac; and, not less, that he certainly knows that he will be ruined if he does not come up to the mark. So, knowing exactly what he has to do, and how to do it, and what will happen if he fails to do it, he makes good, and abstains from talking nonsense and heresy about his relentless, cruel environment, even when the thermometer goes below zero; or about winter being a curse. In a word, he becomes a philosopher, in the primary sense of the word; and the idea of a long, weary gamble with malignant frost and ice finds no place in his mind.

The man on the land in Australia, Sub-tropical South America, and South Africa, has to carry out his work on a different basis, inasmuch as he has to learn how to adapt himself to Nature's arrangements for giving the land its needed rest and sweetening, not by a regularly, annually recurring winter-sleep, but by a periodical but not regularly recurring drought-sleep. Nature, in Australia, has provided a genial climate, with splendid natural pasture-grasses and fodder-plants; with no hard, annually recurring winter, requiring the man on the land to house his stock, and grow crops to feed them under those circumstances, as well as to cull out all but what he can feed, and, in many cases, with procurable water, though it may not always be visible on the surface. Nevertheless, he has not yet learned to live in harmony with his environment so successfully as his representative in the Northern Hemisphere, because, though he knows from experience or from historical records that droughts are certainly to be looked for from time to time, he cannot tell from the almanac exactly when to expect them. This recurrence of droughts at uncertain intervals, which he cannot calculate—and Science cannot definitely help him in that respect at present—is a disturbing factor which periodically makes his environment erratic, and puts him out of harmony with it. This uncertainty introduces the temptation to take chances, which may be disastrous, and underlies the idea of the "Gamble out West."

What Australia needs to learn, by the guidance and co-operation of Science—and there is no better way of doing it—is, how to insure against damage by droughts. That is:—(1) How to prevent the production of "necessitous farmers," requiring State aid, to the amount of about £1,000,000, in order to rehabilitate themselves after a visitation of drought. The State Treasurer reports that, already, £600,000 has been disbursed for this purpose. Do hard winters in the Northern Hemisphere ever or often produce "necessitous farmers" requiring to be relieved by the State to such an amount?

(2) How to prevent droughts from culling the herds and flocks on the customary colossal scale; and from obliterating the promise of harvests.

This can be expressed in another way—How can the man on the land in Australia, with the aid of Science, learn to solve the following questions?

1. In attempting to insure against, or to cope with droughts, is he attempting to accomplish the impossible; or is he only in some districts, or in some cases, trying to accomplish the impossible?

2. Or is he attempting to accomplish the possible (*a*) in the right way; or (*b*) with good intentions, but with insufficient knowledge or equipment, or with inadequate recources?

From time to time, especially on festive occasions, important personages indulge in forecasting the future population of Australia as 100,000,000, or even 200,000,000, and in descanting upon the necessity of filling up the empty spaces of the continent; but, in the reports of their speeches in the newspapers, as far as I have seen, without insisting on the very necessary stipulation—if and when Australia learns, or is going to learn, or has learned, how to cope with drought problems. The strength of a chain is the strength of the weakest link. The population that Australia can support is the population that she can safely carry when droughts come. The State is recovering in part from a very severe experience of drought. Great activity is being displayed in all the States in the way of facilitating the settlement of returned soldiers and immigrants on the land. This seems to me to be an opportune occasion for asking what, I think, is a proper and a pertinent question, because drought-problems are primarily scientific problems, and, therefore, the guidance and co-operation of Science is needed for their solution. The question I would ask is the two-fold neglected question: How is it, seeing that drought-problems are so very important, that we have no handbook, or manual, or *vade-mecum* of Australian drought-problems; and if not, why not; and how soon may we look forward to having one? We have manuals of the flora, of the fauna, of the birds, of the fishes, of the fungi, of the fodder-plants and grasses, of the minerals and fossils, and so on; and we know them to be of fundamental importance, and to be most helpful and suggestive, in the investigation of problems to which they relate. In anticipation of the visit of members of the British Association for the Advancement of Science in 1914, an admirable series of handbooks, one for each of the older States, and one for the Commonwealth as a whole, was published. These served not only for the enlightenment of the visitors, but are standard works of reference to-day. What I have in view is something different from these, and something which is not intended in any way to clash with, or supersede the publications of the State Department of Agriculture, for example, some of which contain articles bearing upon some aspect or other of drought-problems. It is not to be a book to teach the man on the land how to grow crops, or how to raise stock, primarily, or how to accumulate shekels, or anything of that sort. It is to be a book solely for the purpose of setting forth the complemental, theoretical side of the practical activities of the man on the land, especially in relation to drought-problems, with the object of enabling him to understand what it is he needs to learn in order to make the most of his resources in providing against disaster; that is, how to live and keep in harmony with his somewhat erratic environment; and to

understand that drought is not a curse, and that he is not called on to fight droughts, but to fight his ignorance about how to cope with them, which ought to be, sooner or later, enlightenable, provided that Science is afforded an opportunity of helping him.

Apart from the fact that no such book as I have proposed is available at present, the need of such a book is not that nothing at all is known about drought-problems, but that so much of what is known is to be found in back numbers of newspapers or in scientific journals, where it is not accessible to those who want it, and could make use of it; and that these contributions to knowledge deal only with particular aspects or cases, and not comprehensively with the subject in its entirety. What is wanted, as I think, is a self-contained handbook of the complementary, theoretical side of drought problems. I give a sketch of the ground that, in my opinion, might be covered by it, just as something for consideration and discussion.

Synopsis.

Nature and Man, Nature's Insurgent Son—Disturbance of Nature's Balance by Settlement, and what that involves; the reckless or careless introduction of undesirable Aliens, like Rabbits, Prickly Pear, &c.; and the reason why they flourish in their new environment—Droughts: their History and Periodicity in Australia—Droughts in South Africa, and Sub-tropical South America—Their Cause and Meaning in the Economy of Nature: Nature's two ways of resting or sweetening the land, and, at the same time, of clearing up, putting things in order, and striking a balance, by (1) severe cold, or (2) more or less intense aridity—The year after a drought, the bumper year for crops and herbage, and the scientific explanation of the resting and sweetening of the land—The Lessons to be learned from the high level and low-level Flood-plains of the Hawkesbury River Valley, as in evidence at Richmond; and from the desiccated Lake Eyre Basin of Central Australia, called by Gregory "The Dead Heart of Australia"—The Adaptations of the indigenous Plants and Animals to arid conditions, and the lessons to be learned from them—the Man on the Land in the Northern Hemisphere, with an annually recurring hard winter, in harmony with his environment—The Man on the Land in the Southern Hemisphere, with mild winters but periodical droughts, whose periodicity cannot at present be calculated, not yet wholly in harmony with its environment—The need to conserve the Fertility of the Soil, and the indigenous grasses and fodder-plants—Disturbance of the Soil-organisms, and of their long-standing association with the indigenous Plants, especially the Acacias and Eucalypts; the Bionomics of Soil-organisms in the arid portions of the Continent; and the risks from strong, dry, westerly winds, in the absence of a covering snow, when the natural covering of the ground has been removed—Lessons from Droughts; and the Application of the Lessons—Bibliography, as a guide to more detailed consideration of special subjects—Index, &c.

Happily there have been and are men on the land in Australia who have learned that droughts are not a curse, though rabbits and prickly pear may be; that the land needs a periodical rest or sweetening; that it is the dry climate and the high-class nutritive native grasses and

herbage which are largely responsible for the excellence of Australian wools; that if every season were a good one, the stock and sheep would suffer severely from parasites, and from diseases; and, best of all, men who do not believe that Nature's great scheme of things, which, by slow degrees, has evolved from the womb of Time, has arrived at its present advanced state of development for the sole and only purpose of gratifying the money-making instincts of the Get-rich-quick Dollarton Shekelfords, just as and how they would like to be able to order it. Records of the actual experience of intelligent and enlightened men of this kind are among the things wanted; and some of it is already on record in the files of old newspapers. They are men who can appreciate the words of Mr. Roosevelt, when President of the United States, in his opening Address to the American Forest Congress, held at Washington, January, 1905—"All of you know that there is opportunity in any new country for the development of the type of temporary inhabitant whose idea is to skin the country and go somewhere else. . . . . That man is a curse and not a blessing to the country. The prop of the country must be the business man who intends so to run his business that it will be profitable to his children after him. . . . I ask, with all the intensity I am capable of, that the men of the West will remember the sharp distinction I have just drawn between the man who skins the land and the man who develops the country."

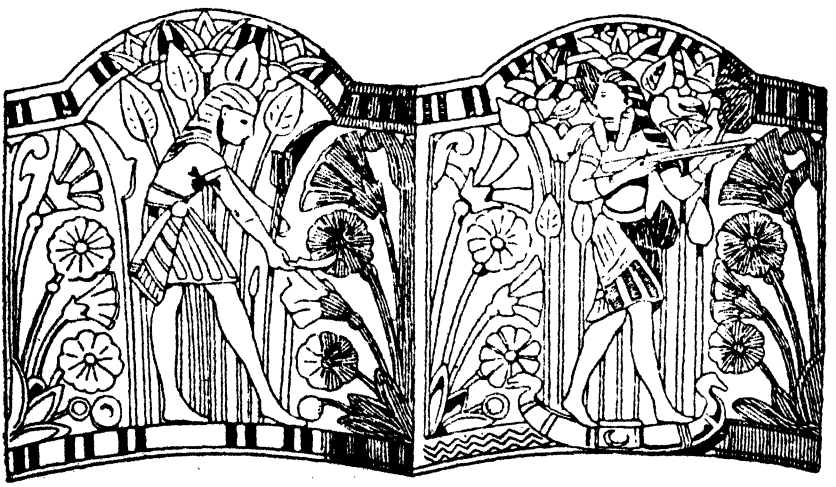
The book should not be a one-man book, but a team-work book, supervised by a capable editor. It should be simply but scientifically written by specialists in the different branches, after the manner of the handbooks prepared, at different times, for the meetings of the Australasian and of the British Associations for the Advancement of Science. But, for the chapters to which they relate, and especially those on the lessons of droughts and their application, from the practical man's side, the files of the newspapers, at least as far back as the drought which began in 1888, should be systematically looked up. Some of the articles therein are excellent, for they are often the records of actual experience and first-hand knowledge; and, as such, they are of historical interest. The cream of all these should be skimmed, supplemented as may be required, and put into the handbook; and, if desirable, referred to in the bibliography. Papers in scientific journals should be utilized in a similar manner.

But the publication of a handbook, in the way of propaganda, is not enough. The annual output of books is so enormous that any particular book is apt to be put on the shelf, and perhaps forgotten. Therefore, some propagandists are needed. A good way of providing for these, I think, would be the endowment of a course of three annual lectures. One lecturer always to be a scientific man; another always to be a man on the land; and the third always to be a business man capable of dealing with the statistical and financial aspects of drought-problems. The lecturers to be appointed annually, a year in advance, so that they may have time for the preparation of their lectures. The lecturers to be allowed to choose the subjects of their lectures, provided—and this is to be a *sine qua non*—that the aim and object thereof is to elaborate, to expound, to make clear, and, if possible or necessary, to amplify the handbook. The lectures sometimes to be delivered in Sydney when the primary producers come to

hold their annual congresses; and, sometimes in one other of the centrally situated and accessible country towns, as may be decided. In this way, attention would periodically be focused on the handbook, and on the subject with which it has to do. Discussion thereon would be promoted. If taken up and entered into enthusiastically, the subject of drought-problems should become a live subject, as it ought to be, and as it needs to be; and then we may expect to make some progress.

Next only to the need of righteousness, and of the maintenance of the integrity and welfare of the Empire, the question of how to cope successfully with droughts in Australia stands second to none in its importance. For Australia's bid for greatness rests upon this, inasmuch as her agriculture and other possibilities can only be imperfectly realized without it.

Investigations carried out by the United States Bureau of Entomology into the parasitism of the Mediterranean Fruit Fly in Hawaii indicate the consistent ascendancy of parasites over the host larvæ. For the year 1918 it was found that the total parasitism of all the fruit-fly larvæ under observation amounted to 55.8 per cent. Thus the value of the parasites had consistently increased each year since their introduction, conferring benefit upon the people of Hawaii by greatly decreasing the infestation of those fruits which are less susceptible to fruit-fly attack, and which include the majority of fruits of commercial value, and upon the fruit-growers of the United States by greatly decreasing the danger of introducing fruit flies into that country.



White Earthenware Investigations.

(From the following Progress Report of the Special Committee, at Ballarat, appointed by the Institute of Science and Industry to investigate the manufacture of white earthenware in Australia, it will be seen that a considerable amount of very useful work has been done, and that valuable data have been obtained. Unfortunately there has been delay in securing special machinery required for the manufacture of various articles, but upon its arrival it is expected that practical demonstration of the fact that the Committee has gone a long way towards the solution of the problem it is engaged upon will be possible.)

Kaolins.—As previous work had demonstrated the fact that ample supplies of high-grade kaolin are to be found in the Ballarat district no further samples of this clay were tested.

Ball Clay.—Although Victoria is well provided with white semi-plastic kaolins, yet considerable difficulty has been met with in obtaining a good plastic ball clay. Large supplies of sub-basaltic clays occur in the neighbourhood of Melbourne, but have first to be tested. One of the likeliest areas is the neighbourhood of the great valley of Victoria which extends from Dandenong to Bairnsdale. Samples of clay were accordingly obtained from Gormandale, Morwell, Longford, Flynn's Creek, Moondarra, and Won Wron. Samples of the clay overlying the lignite deposit at Lal Lal were obtained from the bores that were recently put down by the Victorian Mines Department, and a shaft was sunk in order to obtain a bulk sample. The results of a large number of tests carried out on clays from the above localities prove that the ball clays investigated up to the present are not as plastic as in England. This necessitates a greater proportion of ball clay in the biscuit, and a consequent loss of whiteness in the finished biscuit.

Cornish Stone.—A very important essential in the manufacture of white earthenware is the felspar. As pure felspar is not very plentiful in Victoria, it was decided to employ a felspathic material known as pegmatite or Cornish stone. It is most important that this material should be absolutely free from biotite, as this mineral causes black specks in the finished ware. Bulk samples of Cornish stone were obtained from selected localities in N.E. Victoria; that from Tallangatta proved of little use owing to the presence of small quantities of iron, but the sample from Barnawartha has been found suitable for commercial use. As the tonnage of suitable Cornish stone located up to the present is not large, it is intended to make a careful examination of the occurrences of pegmatite in this area.

Constituents of Bodies.—A series of parallel tests were run in order to show the comparison between quartz and flint in earthenware bodies. Although a great number of cases were tried, it appears that quartz serves to supply the free silica quite as effectively as flint. As quartz is much more easily obtained in Victoria, it was decided to use it in place of the flint.

An extensive series of tests with bodies containing varying quantities of Cornish stone has demonstrated that the porosity of the biscuit burned at 1,200 degrees C. is largely dependent on the percentage of Cornish stone present, and that a porosity of less than 2 per cent. can be obtained in an eight hours' burn at that temperature with a percentage of Cornish stone equal to 19 per cent. Other sets of tests have been carried out to show the best temperature for burning bodies, the effect of the presence of cobalt salts on the colour of the biscuit, and the effect of the various salts in maturing semi-plastic clays.

Glazes.—The glazes tried are all "raw" and "hard."

The glazes of the type $\left.\begin{matrix} .3K_2O \\ .7CaO \end{matrix}\right\} .5Al_2O_3, 4SiO_2,$

and many variations of the above, by varying each and all of the constituents were fusible at and about 1,200 degrees C., but would not cover or mature.

The addition of zinc oxide greatly lowered the fusion point and improved their covering capacity and finish and appearance, but the series is not yet complete.

Two glazes promise well, *i.e.*—

1. $\left.\begin{matrix} .35\ K_2O \\ .30\ ZnO \\ .35\ CaO \end{matrix}\right\} .5Al_2O_3, 3SiO_2$

K_2O	...	10.6 per cent.
CaO	...	6.3 per cent.
ZnO	...	7.8 per cent.
Al_2O_3	...	16.5 per cent.
SiO_2	...	58.8 per cent.

2. $\left.\begin{matrix} .35\ K_2O \\ .30\ ZnO \\ .35\ CaO \end{matrix}\right\} .4Al_2O_3, 3.2SiO_2$

K_2O	...	10.6 per cent.
CaO	...	6.3 per cent.
ZnO	...	7.8 per cent.
Al_2O_3	...	13.1 per cent.
SiO_2	...	62.2 per cent.

Machinery.—Although the special machinery required for the investigation was ordered from six to nine months ago, it has not yet been delivered.

Outside Work.—A fair amount of clay testing has also been done outside the scope of the investigation in order to assist private enterprise. These number twenty-five different clays, and required the preparation of 100 test pieces.

The Economic Value of Our Native Birds.

By S. A. WHITE, C.M.B.O.U.

The economic aspect of Ornithology has been very much neglected in Australia, and there is not the slightest doubt the country will suffer severely through this neglect. The food habits of our native birds is of the greatest importance, owing to the steady increase of the worst insect enemies to agriculture, because it is well known that these insect pests have their enemies in many of our native birds. Mention only need be made of such destructive insects as wireworms, leafhoppers, weevils, black beetles, to understand the enormous number of enemies the farmer has to contend with

If insect pests are considered from the point of view of their attack upon the most important crops, those that come first would be those which live upon corn or grain crops, the foremost being the wireworm, the leafhopper, and the weevil. It is known to ornithologists that 29 species of our native birds prey upon these very insects, as has been proved by stomach contents. Two species of small bugs are injurious to corn, by the larvæ boring into the stems, and this family of insects is known to be devoured by 32 of our native birds.

They are not only the worst enemies to agriculture which attack grain crops, but there are insects destructive to fruit, forests, garden crops, and a host of others, causing economic loss. Each and every one has its bird enemies. Is this fact not sufficient to induce the man upon the land to encourage his best friends around him, and for him to do all in his power to protect them? Next to the enforcement of protective laws, no method is of more value than the education of school children in a knowledge of bird life. If the children are taught that the bird life around them is necessary for their existence, and that they should not disturb, much less kill, many birds will nest and bring up their young which otherwise never reach maturity. Courses in Nature Study have been found not only interesting, but exceedingly profitable. Boys and girls in the country should be taught to know every animal, bird, tree, shrub, and plant by its correct name, and its uses; then we will have the men and women of the future protecting our fauna and flora beneficial to the country.

The United States is an example of a country having made mistakes in this respect in the past, but it is now spending large sums of money annually to encourage the increase of her useful indigenous avifauna. Many European countries have their rigid game and bird protection laws, and what is of greater importance, they see that these laws are enforced. Many of these countries are struggling for an existence at the present time, but past experience has shown them the value of preserving the useful birds indigenous to their land, and, although they can ill afford it, they are devoting public funds to this purpose. Surely it is high time Australia awakened to the fact that it is necessary to protect her bird life in the interests of her primary industries.

Always the cry is for greater production—for two blades of grass where but one grew before. These people who are continually reiterating this parrot cry should pause for a moment to reflect upon how much insect pests

lay toll. A little knowledge may be a dangerous thing, but a complete absence of it is appalling. Insect pests are the cause of loss to the primary producer of hundreds of thousands of pounds annually, and no effort is made to reduce this wastage by calling to our aid the natural enemies of these ravagers.

Little or no education is given in public schools, in primary schools, or in agricultural colleges upon economic ornithology. The annual damage done by insect pests in America is stated in the *Year-Book* to be 700 million dollars, and in Canada the authorities state it to be 125 million dollars. In Australia we have no records, but it represents a large percentage of the value of the crops. An enormous amount of labour is devoted to growing food for insects, and, at the same time, great effort is spent in killing or driving away birds which live upon the pests. Can we wonder then at the rapidity in the increase of the insect pests, which, in many cases, devour everything before them, and cannot be kept in check even by continual and expensive labour? There is not the slightest chance of reducing the great increase of labour each year until a stop is put to the criminal and senseless slaughter of our native birds in Australia.

No species of vegetation seems immune from the attacks of some form of insect life, found in every possible form and situation, from the smallest caterpillar in the bud or curled-up leaf, myriads of flying pests, to the grub in the ground, which is eating away at the roots of the plant. Man has invented many wonderful machines to do all kinds of work, but he will never invent anything for the destruction of insect pests equal to the bird's bill. These little unpaid workers are doing the work no mortal hands can do, and the different species are working both by day and by night.

The answer may be made that all birds are not insectivorous. Quite so; but most birds exist upon insect food during the earlier period of their lives. The great good rendered by bird life at nesting time is tremendous, for the thousands of hungry little fledglings devour immense quantities of insects during the time they are in the nest, and for some time afterwards. Take, for instance, the quail, a family of wonderfully useful little birds. The quail is looked upon by the sportsman as being created for nothing else but to supply sport and food. What a great mistake this is, for all the quails are of the greatest economic use to the man on the land. The quail is a very prolific bird, having 5, 6, 7, and often 9 or 10 chicks to a brood. The young leave the nest almost as soon as they are hatched out, and for the first few days live almost entirely upon insect diet, the insects being brought to them by the parent birds, and it is only stating a fact to say that in the early stages of its life a young quail will consume its own weight in insect life daily. Can one imagine the good done by hundreds of these birds and their broods in crops, gardens, or grazing lands? Not only does the quail destroy immense quantities of injurious insect life, but it is a great consumer of noxious weed seeds, and once these seeds have been swallowed by the quail they are completely destroyed. The writer has taken 300 onion-weed seeds from one quail's stomach, 700 pig-weed seeds, besides other noxious plant seeds, from another. The hunting out and destruction of the numerous insect pests, also the minute seeds of harmful plants, could never be done by human hands.

Many of our most despised birds are of the greatest economic use. Take the crow, a bird towards which much prejudice is shown, despised because it is black, and carrion eating, called a bird of "bad omen," yet, by investigation,

it is shown to be most valuable, and the most effective check upon the blow-fly pest. Investigations of stomach contents carried out by the writer have proved this without a doubt. Northern squatters have now come to the same conclusions, based upon observations, and it is known as a fact that where those men once paid for killing the crows upon their runs, they will not allow one to be killed now. There can be no denying the fact that the crow will gouge out the eyes of weakling lambs, and out of bogged sheep, but the few lambs or sheep that can actually be said to have been lost in this way (for in many cases the animals would have died, owing to weakness or not being discovered in time) is very little payment for services rendered. Apart from the beneficial work of scavenging and the destruction of blow-fly larvæ, they destroy immense quantities of injurious insects, especially grasshoppers and crickets in all stages.

Taking seven stomach contents of the crow, from a large list examined, they are as follows :—

No. 1.—Taken in November, 1910—Number of maggots and small insects.

No. 2.—Taken in November, 1910—Maggots, beetles, blow-flies, ants.

No. 3.—Taken in December, 1910—Full of grasshoppers, some large ones.

No. 4.—Taken in December, 1910—Three species of beetles and grasshoppers.

No. 5.—Taken in December, 1910—Forty-five grasshoppers, some juvenile.

No. 6.—Taken in August, 1913—Beetles, pupa cases of blow-flies.

No. 7.—Taken in August, 1913—Carrion, maggots, pupa cases of blow-flies, and ants.

No. 8.—Taken in September, 1914—Black beetles, pupa cases of blow-flies.

No. 9.—Taken in October, 1914—Carrion and maggots.

No. 10.—Taken in October, 1914—Grasshoppers and beetles

These few stomach contents, taken at random from a long list, must prove that this bird is of the greatest economic value. The crow is a terrestrial feeder, and the food taken by it is on or near the ground. Much of its food is found by digging into the earth by means of its strong bill, given to the bird for that purpose. The turning over of bark, sticks, manure, and clods of earth are common methods of the crow in securing its food. All observers know that the crow devours great numbers of grasshoppers, and he is one of the farmers' and pastoralists' best friends, for he fills and empties his stomach several times during the day. When we hear, upon good authority, that the blow-fly pest is costing the Commonwealth £3,000,000 annually, and we know the crow is a great enemy to the pest, surely this is sufficient reason to place the crow upon the protected list.

The barn or screech owl (*Tito alba delicatula*) is beyond question one of, if not the most useful bird in Australia, and yet it has been much persecuted. The destruction of this bird has been due to many reasons—to superstition, to its noiseless flight, to its weird cry, resembling at times a child in pain, to faulty observations of its true food and habits. This bird's food does not pass through the body as with most other birds, but is retained, till all nourishment has been extracted, then the waste parts, such as bones, feathers,

&c., are ejected from the mouth in the shape of pellets, and from these the nature of this bird's food can easily be arrived at. The dissection and examination of a great many of these pellets has proved the nature of this bird's food. Apart from the writer's own work in this direction, Seebhom,

[S. A. White, Photo.

BARN OR SCREECH OWL *(Tyto alba delecatula).*
From Life.

in his exhaustive history of British birds, holds that the barn owl is undoubtedly the farmer's best friend. He gives an instance in which twenty freshly-killed rats were found in a barn owl's nest. He also says that in 700 pellets of this owl there were found the remains of 16 bats, 2,513 mice, 1 mole, and 22 birds, of which 19 were sparrows.

[S. A. White, Photo.

PELLETS OF A BARN OR SCREECH OWL.
First 3 containing sparrow skulls broken in at the base; 4th, mostly night-flying insects; 5th, mice and rats.

Lord Lelford writes of a half-grown barn owl eating nine mice in rapid succession, and being hungry again in three hours; and also of an old pair of these birds which brought food to their nest seventeen times in half an hour. In view of the unanimity of evidence as to the great utility of the barn owl from men who have carefully studied their habits, the necessity for the careful preservation of these valuable birds cannot be too strongly urged upon the whole community. The testimony of the two observers mentioned above relates to the bird in the Old World. The form found in this country is practically the same in every way, the only exception being a little variation in colouration, and it is distributed through Australia. The barn owl frequents heavily-timbered country when it breeds, and often roosts during the daytime in hollow limbs of the gum trees. In the vast interior, where the trees are not large enough to form breeding places, the bird is found in old wells, mining shafts, caves and crannies of the rocks. Out upon the Nullarbor Plain these birds are numerous; they nest and pass the daylight hours in the numerous "blow-holes" to be found in that country.

[S. A. White, Photo.

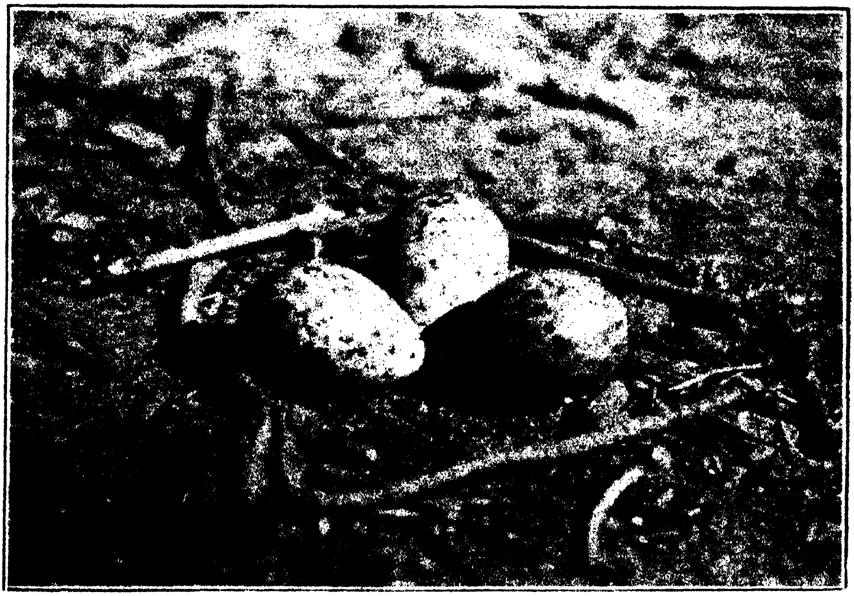
BLACK-BREASTED PLOVER *(Zonifer tricolor).*

Brooding on Eggs.

My own research work in reference to this species of owl has been extended over a long period, and the results have been startling, some thousands of pellets having been examined, and I have proved that one bird, which has been in the habit of perching in a thick *Araucaria Bidwilli* (Monkey Puzzle or Hoop Pine) for some years now, destroyed in less than twelve months 640 sparrows (*Passer domesticus*), 64 starlings (*Sturnis vulgaris*), 1,600 mice, 60 young rabbits, in addition to many rats, and thousands upon thousands of night-flying insects, the latter being mostly very injurious to vegetation. Another lot of 273 pellets from this same bird, during a period of less than nine months, revealed, not counting many thousands of night-flying insects,

[S. A. White, Photo

BLACK-BREASTED PLOVER'S NEST IN DRY LUMP OF HORSE MANURE.
Unusual N st.



[S. A. White, Photo.

EGGS OF THE BLACK-BREASTED PLOVER (*Zonifer tricolor*).

Normal Nest.

630 mice, 50 rats, 2 young rabbits, 233 sparrows (imported), 10 starlings (imported), 1 little water crate, 1 tomtit, 24 frogs, and 1 small lizard. A very striking feature presents itself all through the investigations of the food of this bird, and that is the very small percentage of native birds which are taken in comparison to the imported pests. The native birds do not represent 1 per cent.

Both the spur-winged plover (*Lobibyx novæ hollandiæ*) and the black-breasted plover (*Zonifer tricolor*) are of the greatest economic value, for not only are they moving over the ground in quick short runs during the day time, their sharp eyes ever on the alert for insect life, but they are about by night, thus ridding the land of many very destructive nocturnal insect pests. The plover is a family of very wary birds, but in spite of their smartness, the fox is taking a big toll of them. The plover, as a rule, does not attempt to build any nest, but lays her eggs amidst stones, shingles, or sticks, and depends upon protective colouration to avoid detection, but unfortunately the fox can locate the nest by the sense of smell.

In respect to the spur-winged plover, the following are four stomach contents :—

No. 1.—Grasshoppers, crickets, and several species of small insects, some vegetable matter.

No. 2.—Black beetles, remains of some kind of worms, heads of crickets, grit.

No. 3.—Remains of grasshoppers, some hard seeds, dung beetles, vegetable matter.

No. 4.—Numerous cricket remains, small beetles, vegetable matter, coarse sand.

Three of the banded plover stomachs showed—

No. 1.—Some small crustacea (most likely small crabs), small beetles, and vegetable remains.

No. 2.—Grasshoppers, small insects, which appeared to be some species of bug, seeds of a native berry, small pieces of quartz.

No. 3.—Several heads of caterpillars, seeds apparently of some berry, vegetable matter, coarse sand.

Tidal Power.*

The idea of utilizing the rise and fall of the tides for power purposes has long been a favorite one. Up to the present, however, no power development of this kind, of any appreciable size, has been carried out. The comparatively recent arousing of interest in water-power development in general, and the great advance in the cost of fuel, have been accompanied by a corresponding interest in tidal-power schemes, and their commercial possibility is at the moment the subject of serious investigation in this country and in France.

The power which may be developed from a tidal basin of given area depends on the square of the tidal range, and since the cost per horse-power of the necessary turbines and generating machinery increases rapidly as the working head is diminished, the cost per horse-power of a tidal-power installation, other things being equal, will be smallest where the tidal range is greatest. It is for this reason that the western, and especially the south-western, coasts of Great Britain, and the western coast of France, are particularly well adapted for such developments, since the tidal range here is greater than in any other part of the world, with the possible exception of the Bay of Fundy, Hudson's Bay, and Port Gallelos, in Patagonia.

In Great Britain the highest tides are found in the estuary of the Severn, the mean range of the spring tides at Chepstow being 42 feet, and of the neap tides 21 feet. In France the maximum range occurs at St. Malo, where it amounts to 42.5 feet at spring tides, and about 18 feet at neap tides. The tidal range in the Dee is 26 feet at springs, and 12 feet at neaps, while the mean range of spring tides around the coast of Great Britain is 16.1 feet, and of neap tides 8.6 feet.

Many schemes of tidal-power development have been suggested from time to time. Briefly outlined, the more promising of these are as follows:—

(*a*) A single tidal basin is used, divided from the sea by a dam or barrage, in which are placed the turbines. The basin is filled through sluices during the rising tide. At high tide the sluices are closed. When the tide has fallen through a height the magnitude of which

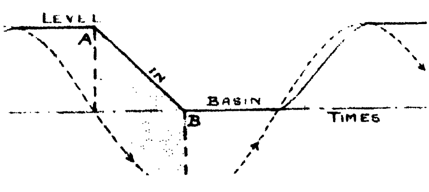


FIG. 1

depends on the working head to be adopted, the turbine-gates are opened, and the turbines operate on a more or less constant head until low tide. The maximum output from a given area of basin is obtained when the

*Reprinted from *Nature*, No. 2640, Vol. 105.

working head is approximately one-half the tidal range, and the cycle of operations under these conditions, and with a constant rate of fall in the tidal basin, is shown in Fig. 1. Here the dotted sine curve represents the level of the sea on a time base. The working period extends from A to B.

(*b*) A single tidal basin is used, with the turbines operating on both rising and falling tides. The cycle of operations is now indicated in Fig. 2. The working period per complete tide extends from A to B and from C to D. Slightly before low water, at B, the basin is emptied

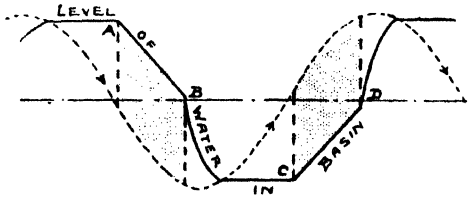


FIG 2

through sluice-gates, and at D, a little before high water, the basin is filled through the sluice-gates. With a working head equal to one-half the tidal range, the period of operation is approximately 50 per cent. greater than in system (*a*), and the work done per complete tide is approximately 50 per cent. greater.

(*c*) A single tidal basin is used with the turbines operating on both rising and falling tides. Instead of filling and emptying the tidal basin through sluice-gates at high and low water, and working under an approximately constant head, the water is allowed to flow through the turbines and to adjust its own level. Under these conditions the rise and fall inside the basin are cyclical, with the same period as the tide, but with a smaller rise and fall and with a certain time-lag. The range in the basin and the time-lag depend on the ratio of the surface area of the basin and of the effective discharge area of the turbines. The working head during each tide varies from zero to a maximum. The cycle of operations is shown in Fig. 3. The working period is from A to B and from C to D, where the head at the points A, B, C, and D is the minimum under which the turbines will operate. The total working period per tide is greater than with either of the preceding systems, and the possible output is somewhat greater. On the other hand, the variation of head during any one tide is very large.

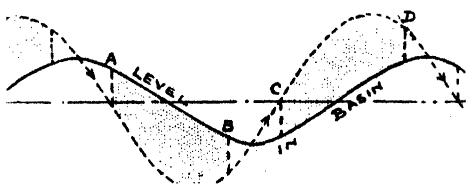


FIG 3.

(*d*) Two tidal basins of approximately equal areas are used, with turbines in the dividing wall. Each basin communicates with the sea

through suitable sluice-gates. In one of these basins, called the upper, the water-level is never allowed to fall below one-third of the tidal range, while in the lower basin the level is not allowed to rise above one-third of the tidal range. The working head then varies from 0.53 H to 0.80 H, and operation is continuous, as indicated in Fig. 4, which shows the cycle of operations. The upper basin is filled from the sea through

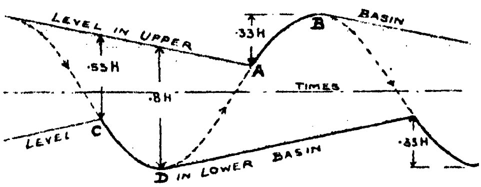


FIG. 4.

the appropriate sluice-gates from A to B, and the lower basin discharges into the sea from C to D. For a given total basin area and a given tidal range the output is only about one-half that obtained in system (a), and one-third that obtained in systems (b) and (c), so that, except where the physical configuration of the site is particularly favorable, the cost per horse-power is likely to prove very high.

(e) Two tidal basins of approximately equal size are used. Turbines are installed in the walls dividing the sea from each basin. Fig. 5 shows the cycle of operations. From A to B the upper basin discharges through its turbines into the sea. From B to E the sea enters the lower basin through its turbines. The upper basin is filled from the sea through its sluice-gates between C and D, and the lower basin is emptied through its sluice-gates from F to G. The head varies from 0.25 H to 0.62 H, and the output is some 25 per cent. greater than in system (d), but the number of turbines required is much greater than in (d).

It is possible, at the expense of additional complication, to arrange in each of these systems that the head shall be maintained constant during any one working period, but since this means that the working head must then be the minimum obtaining during the period, a loss of energy is involved, with a great additional cost of construction and complication in manipulation, and with little compensating advantage.

The great difficulty in developing a tidal scheme as compared with an orthodox low head water-power scheme arises from the relatively great fluctuations in head. In any scheme in which the working head is a definite fraction of the tidal range, the working head at spring tides

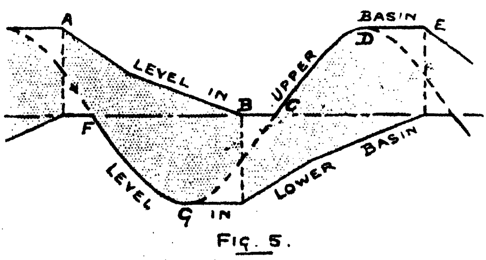


FIG. 5.

is much greater than at neap tides. In the case of the Severn, for example, the working head at springs would be twice as great as at neaps, and the energy output per tide would be four times as great at springs as at neaps, while at St. Malo the output would be 5.5 times as great at springs as at neaps.

Not only is the installation subject to this cyclical fluctuation of head, but in any simple scheme the turbines also cease to operate for a more or less extended period on each tide; and as this idle period depends on the time of ebb or flood tide it gradually works around the clock, and will, at regular intervals, be included in the normal industrial working day. It is true that schemes of operation such as have been indicated are feasible in which this idle period may be eliminated and continuous operation insured, but only at a considerable reduction of output per square mile of tidal basin area. Even in such schemes, unless the working head is fixed with reference to the tidal range at neap tides, the variation of head between springs and neaps causes the output to be very variable.

In any installation, then, designed for an ordinary industrial load, unless the output is cut down to that obtainable under the minimum head available at the worst period of a neap tide, in which case only a very small fraction of the total available energy is utilized and the cost of the necessary engineering works per horse-power will, except in exceptionally favorable circumstances, be prohibitive, some form of storage system forms an essential feature of the scheme.

Various storage systems have been suggested. Electrical accumulators must be ruled out, if only on account of the cost, and the same applies to all systems making use of compressed air. The only feasible system appears to consist of a storage reservoir above the level of the tidal basin. Whenever the output of the primary turbines exceeds the industrial demand, the excess energy is utilized to pump water into the reservoir, and when the demand exceeds the output from the primary turbines it is supplied by a series of generators driven by a battery of secondary turbines operated by the water from the storage reservoir.

Evidently this method is available only when the physical configuration of the district affords a suitable reservoir site within a reasonable distance of the tidal basin. Unfortunately also, considerable losses are inevitable in the process, and the energy available at the switchboard of this secondary station is only about 50 per cent. of the energy of the water utilized by the primary turbines. Where two tidal schemes at some distance apart differ sufficiently in phase, it is possible, by working the two in conjunction, to reduce or eliminate the idle period between tides, and thus to reduce the necessary storage somewhat; but this does not affect the necessity of storage as between spring and neap tides.

Since storage reduces the available output by one-half, and at the same time complicates the system, besides adding considerably to the first cost and maintenance charges, the prospects of tidal-power schemes would be much more promising if the whole of the output could be utilized as it is generated. By feeding into a distributing main in conjunction with a large steam station and/or inland water-power scheme, and delivering to an industrial district capable of absorbing a comparatively large night load, such a state of affairs might be realized, at all

events approximately. There is also the possibility that the intermittent operation of certain electro-chemical processes may be developed so as to enable any surplus power to be absorbed as and when available, and, if so, power developed tidally will probably prove cheaper in this country than that developed from any other source.

Owing to the relatively large variations in working head in any simple scheme, and to the small working heads, the design of hydraulic turbines capable of giving constant speed with reasonable efficiencies, and of moderately high speeds of rotation, is a matter of considerable difficulty. Modern developments, however, promise much better results in both these respects than would have appeared possible only a few years ago, and turbines are in existence which are capable of operating under a variation of head equal to 50 per cent. on each side of the mean, with efficiencies which do not fall below 70 per cent. over this range, and with reasonably high speeds of rotation under the heads available.

Even with such turbines, the number of technical problems to be solved before a tidal scheme of any magnitude can be embarked upon with confidence is large. The questions of single- *versus* double-way operation, of storage, of the effect of sudden changes of water-level due to strong winds, of wave effects, of silting in the tidal basin, and of scour on the down-stream side of the sluices, of the best form of turbine and of generator, and of their regulation and of that of the sluice-gates, are probably the most important, though not the only, subjects to consider.

On the other hand, the possibilities of tidal-power, if it can be developed commercially, are very great. Assuming a mean tidal range of only 20 feet at springs, and 10 feet at neaps, and adopting the single-basin method of development with operation on both rising and falling tides, each square mile of basin area would be capable, without storage, of giving an average daily output of approximately 110,000 horse-power-hours. In such an estuary as the Severn, where an area of 20 square miles could readily be utilized with a spring tidal range of 42 feet, the average daily output, without storage, would be approximately 10,000,000 horse-power-hours.

At the present time it is difficult to obtain an even rough estimate of the total cost of such a scheme, owing to the uncertainty regarding many of the factors involved. The whole question would appear to merit investigation, especially on matters of detail, by a technical committee with funds available for experimental work. As a result of such an investigation, it is at least possible that a definite working scheme could be formulated capable of generating power at a cost at least as small as, and possibly much smaller than, that of power generated from any coal-fired installation.

Scientific and Technical Societies.

ROYAL SOCIETY OF VICTORIA.

At the July meeting of the Society the following papers were read :—

1. The Relationship of the Sedimentary Rocks of the Gisborne District, Victoria, by W. J. Harris, B.A., and W. Crawford. Attention is called to the comparative neglect of a complex and interesting area within 30-40 miles of Melbourne. The Geological Survey classification of rocks in the Gisborne district is set out, and a revised classification proposed, dividing Upper and Lower Ordovician, substituting the Kerrie Conglomerate (already recognised by Victorian geologists) for the Oolitic, and adding a new series—the Riddell Grits. The physiography of the district is briefly dealt with. The problems of the Pyrete Ranges and the effects of the Djerriwarrh Fault are indicated. The distribution of Lower and Upper Ordovician rocks is described, and some account given of their graptolitic fauna. It is shown that the division line between Lower and Upper Ordovician is almost a straight line running through Gisborne in a direction slightly east of north, and evidence is put forward to show that this line probably represents a fault which is shown on the map as the Djerriwarrh Fault. The age is pre-Newer Volcanic, and the down throw is to the east. A tentative recognition of three graptolite zones in the Upper Ordovician is proposed—(Lowest) Diplograptus-Climacograptus with Didymograptus; Dicellograptus without Dicranograptus; Dicellograptus and Dicranograptus. The probability of a higher zone is indicated. This division is set out only as a basis for further work. The widespread distribution of a series of grits, sandstones, and associated shales and mudstones is shown, and some account given of their field relations and fossils. It is held that—(*a*) they overlie Upper Ordovician shales with Dicranograptus; (*b*) they underlie the Kerrie Conglomerate; (*c*) their contained brachiopods and crinoids indicate a mid or newer Silurian horizon, but there is an older element present, the evidence of which is strengthened by the occurrence of Diplograptus and Dicellograptus in interstratified shales. The authors are inclined to place the Grits as Uppermost Ordovician. The Kerrie Conglomerate, in the opinion of the authors, overlies unconformably Diplograptus and Dicellograptus shales and Riddell Grits, and the view is taken that the Conglomerate is in part derived from the Grit. Fossils were found in its boulders similar to those from the Grit. The age suggested is basal Silurian. The Tertiary gravels are briefly mentioned, their metamorphism by the Newer Basalt referred to, and the existence of an east and west fault across the southern part of the district deduced from an abrupt change in their level, corroborated by a similar steepening of grade in the creeks that cross the line.

2. A Geologist's Notes on Water Divining, by Griffith Taylor, B.A., B.E., D.Sc. The writer investigated several alleged cases of water divining while studying the wells around Canberra. A fairly complete description of the procedure at two "divined" wells is given. One was unsuccessful, and the other merely penetrated below the water-table, which was present throughout the district. The writer paid special attention to the alleged "flowing streams," and showed that their direction was contrary to geological evidence. He gave it as his belief that water divining was purely a psychological and not a geological problem. Four illustrations accompany the paper.

3. A Revision of the Australian Cicadidæ, Part I., by Howard Ashton. Since Goding and Froggatt's monograph of the family, published in 1904, many additional species have been described, and a number of errors in nomenclature have crept in. Although the revision is intended to apply to Australian species, it was thought advisable to include those of New Zealand from the fact that the few Cicadas there are obviously descendants of Australian ancestors, all belonging to the widely diffused genus *Melampsalta*. Two new genera and three new species are described, and, with each species, references are given to distinct synonyms, descriptions, and especially figures. Where type specimens are available, the Museum or private collection in which they are contained is indicated.

LINNEAN SOCIETY OF NEW SOUTH WALES.

At the July meeting the following papers were read:—

1. Notes from the Botanic Gardens, Sydney. By A. A. Hamilton, Botanical Assistant.

Species of *Lepidosperma* and *Prostanthera*, and varieties of *Grevillea punicea*, *Hakea saligna*, and *Prostanthera saxicola* are described as new. New locality records are made for several other species.

2. The *Atrypidæ* of New South Wales, with references to those recorded from other States of Australia. By J. Mitchell and W. S. Dun.

In addition to the three species of *Atrypa* already known from New South Wales, three species are described as new. Specimens from Molong, Yass, and Bowning, which externally resemble *Meristina*, but whose internal structure shows them to belong to the *Atrypidæ*, are referred to a proposed new genus. The records of *Atrypa* from Queensland, Victoria, and Western Australia are revised.

3. Note on certain Variations of the Sporocyst in a species of *Saprolegnia*. By Marjorie I. Collins, B.Sc., Linnean Macleay Fellow of the Society in Botany.

In the species of *Saprolegnia* examined, *Leptolegnia*, *Pythiopsis*, and *Achlya* conditions of the sporocyst occurred rarely, while the *Dictyuchus* and *Aplanes* conditions were frequent; the variations occurred in both club-shaped and cylindrical sporocysts, but were not observed arising from resting sporocysts. Composite sporocysts were observed combining the features of *Dictyuchus* and *Aplanes*. Evidence is given in favour of the suggestion that the *Aplanes* condition has arisen from the *Dictyuchus* by failure of the protoplast to escape from the germ-tube during its early growth.

4. The Geology and Petrology of the Great Serpentine Belt of New South Wales, Part IX. The Geology, Palæontology, and Petrography of the Currabubula District, with notes on adjacent regions. By Professor W. N. Benson, B.A., D.Sc., F.G.S.; W. S. Dun, and W. R. Browne, B.Sc. Section A. General Geology (W. N. Benson).

The relationship structurally and stratigraphically between this region and that formerly described by the writer in the Burindi and Horton River districts is indicated. In the Currabubula district the oldest formation is the Burindi mudstone with tuffs, followed by the Middle Carboniferous Kuttung Series, largely composed of keratophyre-tuff and conglomerates, but containing two or three horizons of contorted, seasonally-banded "varve-rock" of fluvioglacial origin, accompanied by tillite containing striated, and occasionally faceted erratics. This series is 9,500 feet in thickness, and contains *Rhacopteris* and other fossil plants. It is followed by the Werrie Series of basalt-flows, which are invaded by a very varied series of sills and dykes radiating from Warragundi Mountain, related to which is an extensive series of keratophyric, andesitic, doleritic, and basaltic sills and dykes which invade the Burindi and especially the Kuttung rocks. The period of intrusion of these was probably during the folding and faulting, which occurred after the formation of the Kuttung rocks, but probably before that of a mass of *Glossopteris*-bearing sandstone, which is referred to the Newcastle Series, though this has been broken by posthumous movements. The physiography of the Currabubula and Peel River district is also discussed.

Dr. E. W. Ferguson exhibited specimens of the imago and larvæ of a muscid fly belonging to an undetermined genus. The imago was bred from a pupa taken in the nest of a Leatherhead by Messrs. W. G. and R. C. Harvey, of Mackay, Queensland. The larvæ live on the nestling birds, and when mature conceal themselves in the nest and pupate. Out of twenty pupæ obtained by Messrs. Harvey, only one hatched out, the others being parasitized by a chalcid wasp, a pair of which were also exhibited. Mr. P. H. Gilbert, of Lakemba, Sydney, has found what appears to be the same species on nestling birds (New Holland Honeyeater).

Mr. E. Cheel exhibited some very interesting specimens of a rare lichen collected on Mount Kosciusko by Miss A. V. Duthie.

The only specimens previously collected, so far as can be ascertained at present, are in a solitary collection by Rev. F. R. M. Wilson, found on earthy rock on Mount Hotham, Victoria, in January, 1890. The specimen is labelled *Dufourea madreporiformis* (Wulf.) Ach. (Wilson No. 1157, in National Herbarium, Sydney). It seems to have close affinities with *Dactylina artica* (Hook.) Nyl., and further investigation is needed to settle the generic position, as no apothecia are present in either the Mount Hotham or Mount Kosciusko specimens. Unfortunately there are no specimens of the above-mentioned genera (recorded from Arctic Regions) available for comparison.

SCIENCE AND INDUSTRY.

THE ROYAL SOCIETY OF QUEENSLAND.

At the June meeting Mr. H. A. Longman, F.L.S., exhibited a number of marsupial crania, showing variations in the perforations of the cribriform plate, and pointed out that members of the Polyprotodontia (*Perameles, Myrmecobius, Thylacinus, Sarcophilus, Dasyurus, Phascologale*, &c.) were characterized by the presence of two major perforations situated near the superior median margin.

Mr. C. T. White, F.L.S., exhibited (1) pieces of the stem of *Vitis acris* F.v.M. When collecting in the Rosedale district recently Mr. Schmieden had told him that when the stem of this vine was chewed, the tongue and lips became inflamed, the secretion of saliva was increased, and intense pain ensued. (2) Seeds of *Macrozanomia macrocarpa* Cogn., collected in the Aru Islands by Mr. Snowden, who had forwarded them to Mr. M. J. Colclough, of the Queensland Museum. Mr. Snowden stated that these beautifully winged seeds were sometimes found floating about in the air 10 miles out to sea, and not uncommonly fell on schooners' decks. The exhibitor stated that he had observed specimens on the road between Bioto and Mafulu, in Papua, while collecting in that region. The seeds had previously been described by the late F. M. Bailey in the Society's Proceedings (xviii., 3) as those of an unknown Bignoniaceous plant. For the correct identification Mr. White was indebted to the Director of the Royal Botanic Gardens, Kew (Lieut.-Colonel Sir D. Prain), who, in forwarding the determination, stated that an article on this interesting plant had been prepared for an early number of the Kew Bulletin.

Mr. W. D. Francis read a paper on "The Origin of Black Coatings of Iron and Manganese Oxides on Rocks." The author described black coatings of iron and manganese oxides on rocks in streams of the dense rain forests of the Kin Kin District (which is situated in the coastal belt, about 100 miles north of Brisbane), and stated that it is highly probable that they are the altered remains of a fine, red, rock-incrusting alga (*Hildenbrandtia*). This conclusion is supported by the following facts:—(*a*) The correspondence in distribution of the black coatings and the incrusting alga; (*b*) comparability of thickness of the black coating and the alga; and (*c*) the presence of the cellular structure of the alga in 50 per cent. of the examples of the black coating rendered transparent by hydrochloric acid. Coatings of apparently similar chemical composition observed by Humboldt, Darwin, and others on rocks in the Orinoco, at Bahia, and in the Nile and Congo are briefly referred to, and it is suggested that they may be the remains of incrusting organisms.

Personal.

MR. C. S. NATHAN.

Mr. C. S. Nathan, whose photograph appears in this number of the *Journal,* has been a prominent member of the Executive for three years.

Mr. Nathan was born in Melbourne, and, when very young, went to New Zealand, where he was educated and began his business training. Attracted by the possibilities of Western Australia, he went to that State in 1894, and has been actively engaged in business there from that time. For the past twenty years he has been Manager, and, of late, Managing Director, of Charles Atkins & Co. (W.A.) Ltd., an electrical engineering firm of Perth.

For many years Mr. Nathan lived in Fremantle, and was a Councillor of that town, and one of the original members of the Tramway Trust. Mr. Nathan has been one of the few men actively engaged in large business transactions who have realized the value of the application of science to industry, and years ago established a scientific department in his business. He has actively associated himself with the scientific development of Western Australian industries, and has been Chairman of the Council of Industrial Development in that State. This Council was established by the Western Australian Government to investigate industrial possibilities, and to assist in establishing new industries utilizing local materials. As a result of its activities some investigations have been made, and several very important industries, such as bottle making, wool scouring, and ceramic products, have been set up in Western Australia.

The work of the Council was closely related to that of this Institute, and at the request of the Western Australian Government Mr. Nathan was appointed a member of the Executive, and has frequently visited Melbourne to assist in its work.

He has been one of the most enthusiastic workers for establishment of the Forest Products Laboratory, and is a member of the Special Committee in charge of that project.

During the war, Mr. Nathan devoted the greater part of his time to such public work as has been stated, and to definite war work. He was Chairman of the very successful Citizens' Appeal Committee for the Y.M.C.A., and a member of the Executive of the Red Cross Returned Nurses Home, Australian Comforts Fund, and the Perth Hospital.

On a recent trip to America, Mr. Nathan collected a large amount of valuable information in reference to mechanical cotton pickers, the fur industry, and cattle tick.

REVIEWS.

Forest Products: Their Manufacture and Use.—Nelson Courtlandt Brown, B.A., M.E., pp. xix. + 471, with 120 illustrations. John Wiley and Sons, New York. The book purports to present to the student and general reader the chief commercial features involved in the manufacture and use of the principal forest products, except lumber, and to serve as a reference book for those interested. Apparently it has been written as a text book for students in American forestry schools, and from this point of view it is probably satisfactory. As a reference book, however, the treatment of each of the many divisions covered is too brief. The statistical tables, which form so prominent a feature of the book, are practically entirely American. It would have been of value if some statistics from other countries were added for comparative purposes, especially for students. Some of the tables are unsatisfactory. For example, in a book where so much has had to be sacrificed to economy of space, it seems hardly worth while giving a whole page, as on page 339, to details of wood fuel used on farms. The photographs generally are not good, as many of them have so much detail crowded in that it is difficult to see the essential features. It is to be regretted that some important matters have been curtailed, while space has been found for illustrations which in many cases serve no useful purpose. The book is, however, very readable, and, for the general reader requiring a clear and simple account of the various processes dealt with, is of undoubted value. The information is accurate, and set out clearly. It is as a book of reference that the publication fails, owing to the scant treatment necessary to deal with so many subjects in a reasonable space. For example, the beating of paper is dealt with in a few lines, and the very important and growing ply-wood industry gets very little space. One noticeable omission is a discussion of gums, resins, and essential oils. Turpentine is the one exception. In the chapter on Tanning the African black wattle is referred to as *Acacia Natalita*, whereas it is *Acacia decurrens*, var. *mollis*. Very interesting accounts are given of such subjects as pulp and paper, tanning materials, veneers, cooperage, distillation, ties, posts, poles, shingles, fuel-wood, maple syrup, rubber, dyewoods, excelsior, and cork. The ground covered is, of course, very extensive, and it is to be hoped that the author will carry out his expressed intention of dealing fully with these important subjects in a series of books. Such a treatment would allow of the result being of real value as books of reference, and, as the present literature on forest products is very scattered, Mr. Brown would do a great service in presenting it in a form readily available.

Classification of Australian Wheats.—A bulletin (No. 19), containing a classification and detailed description of some of the wheats of Australia, has been issued by the Institute of Science and Industry. This bulletin gives the results of the work which has been done up to the present by the Seed Improvement Committee of the Institute of Science and Industry. This committee was formed with the object of dealing with the following problems:—

(1) The nomenclature of cultivated varieties of farm crops.

(2) The exchange and dissemination of seed samples for research work.

(3) The elimination of undesirable varieties of crops.

(4) The recommendation of money grants to approved State or other institutions for work in connexion with seed improvement, and the introduction of improved varieties of crops.

REVIEWS.

In accordance with instructions from the Executive Committee, work was commenced on the nomenclature of farm crops, and specimens of the different varieties of wheat, oats, and barley were collected from the experimental farm in each State. Wheat, being the most important of the cereals, was the first one to be considered. It was found that, in order to deal with the nomenclature effectively, it was necessary to compile a classification of the varieties, and also a detailed description of each variety, in order that it could be taken as a standard for comparison.

Part I. of the bulletin deals with the classification, giving a detailed description of the characters which may be used to divide the varieties into classes and types and an account of the classes which are formed on these characters.

The main classes are formed on the presence or absence of awns; the presence or absence of hairs on the chaff; the colour of the chaff; and the colour of the grain. Sixteen classes can be distinguished, and these are further subdivided into types according to certain botanical and agricultural characters.

The botanical characters used in the types described are the solidity of the straw, which may be hollow, pithy, or solid; the presence of awns; the shape of the head, which may be club-tipped, square, or tapering; the character of the outer glume; and the size and shape of the grains.

The agricultural characters used are the stooling property, the seasonal variation or time of ripening, and the character of early growth; but these need more careful investigation and description before they can be counted upon as reliable characters for use in distinguishing between the varieties.

Part II. of the Bulletin gives a short botanical description of the different species of wheat under cultivation in different parts of the world. The grouping of the species is according to the distinguished botanist Hackel. A strictly botanical description of each group is given, and a note as to the extent to which each is grown in Australia.

Part III. gives a detailed description of each of the 46 best known varieties grown in the Commonwealth. Each description has been compiled from the material received from the various State farms, from all the available literature on the subject, and, where possible, with the help of the breeder of the variety. The botanical characters are described in detail, the agricultural characters in brief, and the history or pedigree of each variety is given.

The description of the varieties is preceded by a key or classification, to assist in their identification.

The bulletin has been prepared by Ellinor Archer, M.Sc., Secretary of Seed Improvement Committee, under the supervision of the members of the Committee. Copies may be obtained on application to the Secretary of the Institute of Science and Industry.

Food Inspection and Analysis.—By Albert E. Leach, S.B., revised and enlarged by Andrew L. Winton, Ph.D. 4th edition, pp. xix. + 1090, with 158 photomicrographs and 120 text figures. John Wiley & Sons, New York, 1920. 45s. net.

A copy of the fourth edition of the above book has been received from Messrs. Chapman & Hall, Covent Gardens, London, and the information contained in the work, which is almost encyclopædic in size and character, is brought right up to date—January, 1920. As a new edition of an old and well-known work, it has retained the old arrangements to meet the convenience of those accustomed to the earlier editions which appeared in 1904, 1909, and 1913. There has been considerable advances since the last date, and a large amount of new material has been added to or substituted for those past editions, resulting in an increase of 90 pages.

The recent literature has been well culled, and many references are given as footnotes to the pages. The new edition is due to Dr. A. L. Winton, who is also the author of several books of his own account, and a recognised authority on Food Examination, especially on the microscopical side. It was expected that more chemical microscopy would be found in the present edition, *e.g.*, in the examination of sugars, much confusion existed until the osazone method was introduced, yet no reference is given to the various osazones and their microscopical examination. In the examination of various jellies, no chemical examination can detect fruit adulteration as satisfactorily as the microscopical examination of colloidal precipitates, which are not mentioned; the alkaloids

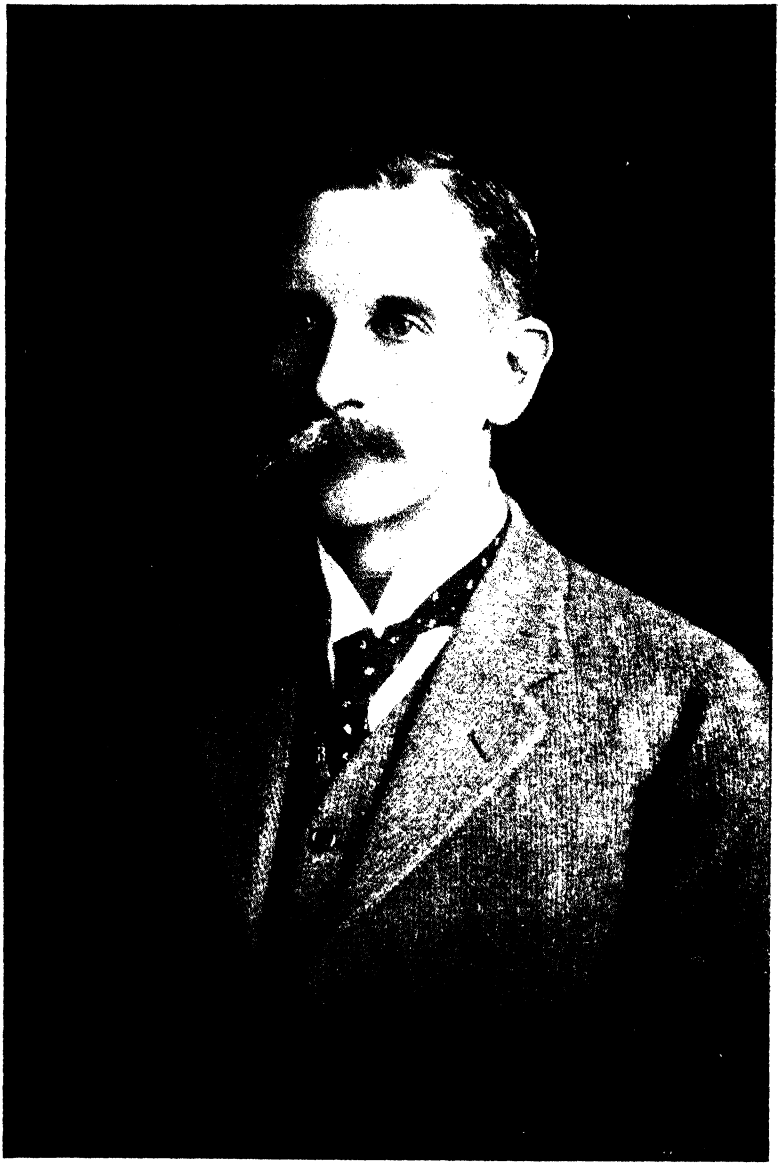
are also readily identified under the microscope. Although it is not the purpose of the present book to go beyond the strictly chemical or physical processes involved in making the analyses, because the sole object of the examinations is to ascertain whether or not such article of food conforms to certain standard of purity, fixed, in some cases, by special law, and in other cases by common usage or acceptance. In the examination of such substances as eggs, milk, preserved foods, canned products—vegetables, fruit, pulp, jams, and jellies—meats and sauces, chemical methods alone do not afford a satisfactory examination. It is stated that the public analyst need not concern himself with the dietetic value of the food, or whether it is of high or low grade. It is for him to determine simply whether it is genuine or adulterated within the meaning of the law—how, and to what extent. Nevertheless, we find a chapter on "Food: its function, proximate components, and nutritive value" included. Though short (13 pages), it is clear and good, and is an indication that the author recognises that something more than mere analysis is necessary. The Food Chemist should work in conjunction with the Physiologist and Bacteriologist, and must thoroughly understand the use of the microscope. The microscopical part of the present edition is mainly devoted to the section on cereals and their products, tea, coffee, cocoas, and spices, and follows the accepted methods. To supplement this, 158 photomicrographs have been included, but, unfortunately, these are very much below the standard of the book—in fact many are quite useless (131, 136, 138, 157, 161, 204, 254): and others appear to have been taken out of focus (165, 166). Generally, too much has been included in each field, and all contrasts are lacking. With the body of the text, however, the author deserves very great commendation. The information is very extensive, and all manner of tables of analyses, equivalents, specific gravities, optical constants, sugars, colours, alcohols, &c., are to be found. The official positions of both the original author and the reviser are sufficient guarantee that the book is thoroughly practical and accurate. Where many methods are given for an examination, it might be of some value if the author's preference were indicated. At the present time, we have to rely on the official method adopted by the American associations. In addition to the chapters already mentioned, there are others on edible oils and fats, alcoholic beverages, food preservatives, artificial sweeteners, flavouring extracts, milk and milk products, apparatus and methods, &c. The chapter on artificial food colours is very useful and a final chapter on the determination of acidity by means of the hydrogen electrode (ion concentration) and its value and applications is given. One hundred and twenty text figures are included. The book will, no doubt, form a standard reference book for the analytical chemist and in addition will be a guide for others, such as the pharmacist, physiologist, and manufacturer.

SOME PUBLICATIONS RECEIVED.

The Peat Resources of Ireland, Special Report No. 2, issued by the Fuel Research Board. In a lecture before the Royal Dublin Society, Professor Pierce F. Purcell discussed the problems involved in dealing with a natural material more than nine-tenths of which is water. The changed conditions which affect the cost of winning coal will also affect that of peat production. Recent attempts made in Canada and Germany in the application of mechanical methods to the winning of peat have shown that a considerable measure of success has been attained, and, so far as Ireland is concerned, the conditions have now placed peat in a more favorable position to compete with coal.

A Critical Revision of the Genus Eucalyptus, by J. H. Maiden, I.S.O., F.R.S., F.L.S.—Part XLI. of the complete work with four plates. The species described are *E. latifolia*, *E. Foelscheana*, *E. Abergiana*, *E. pachyphylla*, *E. pyriformis* var. *Kingsmilli* Maiden, *E. Oldfieldii*, and *E. Drummondii* Bentham.

Report of the Inter-Departmental Committee on Research and Development in the Dependencies of the Falkland Islands.—Recommendations are made, *inter alia*, for research work in connexion with the whaling and sealing industries, and with regard to hydrography, meteorology and magnetism, and geology and mineralogy. Whale oil to the value of £1,500,000 was shipped from the Falkland Islands in 1917-18, and during the same period guano of an equal monetary value was obtained.



MR. J. B. HENDERSON, F.I.C., Queensland Government Analyst and Member of the Executive Committee of the Institute of Science and Industry.

(For Biographical Notes, see page 569.)

SCIENCE AND INDUSTRY.

VOL. 2.] SEPTEMBER, 1920. [No. 9.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Australia's Position in Regard to Liquid Fuels.

THE rapidly-increasing scarcity and dearness of motor fuel is forcing the attention of industrial countries to the problem of future supplies. Mr. G. O. Smith, the Director of the United States of America Geological Survey, recently pointed out, in an address given to the Iron and Steel Institute, that ten years ago the oil wells in America were adding to the reserve stocks about 15,000,000 barrels a year, but now the current is in the other direction, and stocks are being depleted to the extent of some 20,000,000 barrels a year. In 1919, America was obliged to import nearly 50,000,000 barrels of crude oil more than she exported. The official estimate of less than 7,000,000,000 barrels of oil as the quantity remaining available in the ground in the United States of America, while the annual consumption is now nearly 500,000,000 barrels, shows that at the present rate of consumption there are only fourteen years' supplies available.

In America, so serious is the position that every effort is being made to supplement the supplies of petrol. Attention is being given, firstly, to the production of benzol from the distillation of coal; secondly, to the distillation of alcohol from molasses and from other sources; and, thirdly, to the oil-shale resources of the country. It is probable

that with the advent of higher prices for fuel oils a kind of economic survival will be brought about. The more essential use of oil, that is the use of oil where it serves the greatest end, will survive; and business practice and public opinion, and even, if needed, governmental regulations, will work together to enforce obedience to this rule of greatest good to the greatest number.

In Great Britain, leaders of science and of industry are not in ignorance of the dangers threatening. The British Government has established a Fuel Research Station, at a cost of nearly £150,000, to thoroughly investigate the economic and commercial possibilities of obtaining liquid fuels by destructive distillation of coal. Another Government Board has been established to investigate the whole problem of power-alcohol, while various large industrial corporations, such as the London General Omnibus Company, are vigorously prosecuting inquiries into one or other branches of the subject.

In Australia, where the position is more grave, the future is regarded with the utmost complacency. The Commonwealth is at the mercy of the United States of America, and receives only such quantities of liquid fuel as that country permits. It is true that the situation may be slightly alleviated when effect is given to the proposed operations of the Anglo-Persian Oil Company, but even to that limited extent Australia will still be dependent on outside sources for her supplies of the crude oil.

There appear to be four possible ways in which Australia can make herself independent of outside contributors, and develop her own supplies of liquid fuels. These are—

(*a*) Power-alcohol;
(*b*) Distillation of coal;
(*c*) Production of shale oils; and
(*d*) The discovery of local oil-fields.

In regard to the last of these, the Commonwealth Government has taken up the matter, and is offering large rewards for the discovery of oil deposits. In regard to the development of the first three problems, however, it is proposed by the Institute of Science and Industry to make fresh efforts to bring about a satisfactory solution.

The main sources of alcohol are vegetable materials containing starch or sugar, and practically all the alcohol for potable and industrial purposes is now made from grain and molasses. Before the war, large quantities of alcohol were made in Germany from potatoes specially grown for the purpose. Alcohol can also be made from the fermentable sugars formed by the hydrolysis of wood cellulose, and can be made synthetically from calcium carbide or from the ethylene contained in coke ovens and coal gas. From results obtained in America it does not

appear that high yields will be obtained from our hardwoods, but the investigation is one which the Institute intends to take up as soon as facilities are provided for the work. The manufacture of calcium carbide has recently been established in Tasmania, but the development of the industry depends largely upon the availability of cheap power. The recovery of ethylene from coke ovens and coal gas, and its conversion into alcohol, are still in the experimental stages. At the present time, however, none of these three sources of supply is of appreciable importance in this country.

The main recommendations made to the Government in a comprehensive report on the whole subject, in 1918, were—

(1) That a bonus of 6d. per gallon should be granted on power-alcohol distilled in Australia from local raw materials; and

(2) That the whole question of methylation of denaturation should be reviewed sympathetically by the Excise authorities.

The Government has not, so far, taken any action in these directions, but the Institute is hopeful that some results may soon be forthcoming. In Queensland there are very considerable supplies of material which are now wasted, and which can be used profitably for the manufacture of power-alcohol. As the result of action taken by the Institute, the Automobile Club of Queensland has established a strong and influential committee to see what can be done to establish distilleries, preferably on a co-operative basis. Interest is being aroused also in other directions, and the sugar mills in the Cairns district are, for example, taking the matter up with a view to ascertaining the possibilities of establishing a distillery to produce about 1,000,000 gallons annually. As regards other raw materials, the difficulty at the present time is that crops which contain either sugar or starch have such a high value as foodstuffs that it is doubtful whether they can be used profitably for distillation purposes.

The Fuel Research Board in Great Britain is of opinion that coal is now, and is likely to remain, the world's principal source of fuel, whether solid, liquid, or gaseous. By processes of carbonization and gasification, coal can be "sorted out" into gaseous, liquid, and solid fuels, and more economic methods of utilization adopted. Investigations carried out by the Fuel Research Board into the thermal and economic effect of various methods for carbonizing and gasifying different types of coal show that for each type of coal the method of treatment has to be specially adapted. Since the solution of the problem depends, not only on the nature of the coals and particular processes suitable for their treatment, but also on economic conditions, it is highly important that Australia should take part in the investigations which are being

carried out in other countries. Since the appointment by the Institute of an influential and representative committee to inquire into this and cognate subjects, further progress has been stopped by lack of funds.

In shale, Australia has deposits which are the richest in the world. The value of shale as an adjunct to her failing supplies of petroleum is realized by the United States of America, where money has been allocated by the Federal Government for the investigation of problems involved in the commercial exploitation of the large deposits known to exist in that country. The shale-oil industry had its origin in the south of Scotland, and, by dint of scientific management, survived the competition of American petroleum products in spite of the decreasing value of the raw material treated. In Australia, the history of the industry has been much less happy, but the time appears to be ripe for a vigorous exploitation of this potential source of wealth. The liquid-fuel position is now so acute that it does not appear probable that any one source of supply can be relied upon to supply the demand. Alcohol, benzol, and shale petrol will all be required, as well as imported fuels.

—G. L.

EDITORIAL

A BIRD CENSUS.

Some interesting results have been obtained by Professor J. Burton Cleland, of the University of Adelaide, by recording and classifying, during walks or drives in the country, the various Australian birds met with during the outing. His records extend back to March, 1917, and cover visits to eleven districts in New South Wales, Queensland, and South Australia, and were commenced with the object of securing a crude idea of the actual and relative numbers of the individuals of various species of Australian birds, and ultimately, by the co-operation of other observers, of compiling a bird census of Australia. Describing his methods, Professor Cleland writes that he keeps a score, as one keeps the runs at cricket, on a sheet of paper or the back of an envelope, of the number of each species seen, so that eventually when sufficient ground has been covered, results of some value might be expected. For instance, during a motor run from Broken Hill, 84 individuals of eight species were recorded over a distance of 15 miles traversed in one and a quarter hours. The country was mostly open saltbush plain, and the view for small birds was estimated at about 100 yards or less, and for large birds, about 400 yards. From the depth of the lateral view, multiplied by the length of the journey, the average number of birds per square mile was reckoned. The type of vegetation necessarily affects the extent of the lateral view during a journey. In 1919, Professor Cleland explained his scheme at the annual Conference of the R.A.O.U., at Brisbane, and it met with acceptance. It was then pointed out that not only was a rough idea obtainable in this way as to the numbers of our birds, but, by recording results at the present time, and making the same journey again after twenty years' interval, some idea might be obtained as to whether any species was decreasing materially in numbers, holding its own, or increasing. Professor Cleland has prepared his observations for publication, and their appearance will be looked forward to by ornithologists.

BACTERIAL RETTING OF FLAX.

Some years ago attention was drawn to a method of retting flax in water inoculated with a pure bacterial culture. This method was described by Professor Giacomo Rossi, Director of the Institute of Agricultural Bacteriology in the Royal Higher School of Agriculture, Italy, in 1916; and a factory was erected at Bonnetable, in France, where flax is now retted on a large scale. The process depends upon the action of a special aerobic bacillus, and the cultures are supplied from Professor Rossi's laboratory. Recently a report by Mr. A. Renouard of the work at the factory was published in the weekly

bulletin of the Department of Trade and Commerce, Canada, he having been commissioned to investigate the operations, and to make careful observations of the various stages of the process. The method consists essentially of three stages—(1) the immersion of the flax straw in water at 82 to 86 degrees F. in suitable vats; (2) the addition of a certain quantity of the culture bouillon of the bacillus; and (3) in the passage of a current of air through the water in the vats during the whole of the retting process. Mr. Renouard considers that the Rossi process can furnish the best possible results from flax straw of any kind which can be treated. Moreover, as the process can be checked at any moment, the action can be so controlled as to give products answering to all requirements of the flax spinners. The yield of fibre amounts to about 20 per cent. of the flax straw. The Rossi process can also be applied to hemp and ramie, and according to tests made by Professor Rossi it appears that Sisal leaves, when crushed and retted by this method, furnish a good white fibre of better quality than that produced in the usual way.

ELECTRICAL STERILIZATION OF MILK.

The British Medical Research Committee has recently, according to commerce reports, published results of experiments in sterilization of milk by Professors Beattie and Lewis, of Liverpool University, who largely carried on the work. They enumerate the results of fifteen experiments under varying conditions, with different degrees of current, and with several qualities of milk. The final conclusions arrived at by the investigators are:—Milk can be rendered free from *B. coli* and *B. tuberculosis* by the new electrical method without raising the temperature higher than 63 or 64 degrees C. This temperature effect is very short in duration, and in itself is not the principal factor in the destruction of the bacteria. Though the milk is not sterilized in the strict sense of the word, the percentage reduction of the bacteria over a fortnight period is 99.93. The keeping power of the milk is considerably increased. The taste of the milk is not altered, and so far as careful chemical examination can determine the properties of the milk are not in any way impaired. The milk may accurately be described as "raw milk" free from pathogenetic bacteria.

LIGHT CREOSOTE OILS IN WOOD PRESERVATION.

Experiments conducted by the Forest Products Laboratory, U.S.A., have shown that light creosote oils properly injected into wood will prevent decay until the wood wears out, or checks so badly that the untreated portions are exposed. Creosotes used in ties from 25 to 50 years ago were, for the most part, oils having 50 per cent. or more distilling below 235 degrees C., with a residue not to exceed 25 per cent. at 315 degrees C. The ties so treated lasted fifteen to twenty years, and failure was traceable in most cases to mechanical wear, such as rail cutting and spike killing. In no case was failure found to be the fault of preservative. Of 1,558 telegraph poles in the Montgomery-New Orleans line, which were pressure-treated with a light creosote oil, 1,049 poles were still sound after sixteen years. In 91 per cent. of the cases of decay, the fungi had entered the wood through checks and

shakes. Representative sections in the Norfolk-Washington line showed that after seventeen years' service, of the 1,614 poles inspected 1,469 were sound, 92 decayed at the top, and 105 decayed at the ground-line. The decay at the top was caused chiefly by cutting off the poles. In those decayed at the ground-line, the causes of failure, as determined in 88 per cent. of the cases, were checks or shakes. Here again, as in the ties, the preservative outlasted the mechanical life of the wood. Unless some other factor than protection from decay is considered important, therefore, there is apparently no need to specify high-boiling oils. The important point is that any coal-tar creosote which is not extremely low-boiling or extremely high-boiling will satisfactorily prevent decay; and in the selection of an oil, factors such as price, penetrability, and convenience in handling should receive greater consideration than moderate differences in volatility.

SCIENCE AND INDUSTRY.

The ironfounding industry of Great Britain, through the Institution of British Foundrymen, have decided to form a Research Association. It is intended primarily for the grey and malleable cast-iron trades, and the scheme will be under the auspices of the Government Department of Scientific and Industrial Research, which has £1,000,000 for furthering such work. It is proposed to have the offices and laboratories, and bureau of information, in Birmingham, and Mr. T. Vickers has been appointed technical adviser. He is secretary of the Birmingham Metallurgical Society. Ironfounding is greatly in need of the aid of science, and hitherto it has not drawn a good class of labour. There are 2,800 foundries in Great Britain—285 being in Scotland, and 50 in Ireland. In the Midland area there are 828; and Birmingham has the most foundries of any town—118. Yorkshire has the largest number of any county—415.

SEA-WEED FOR PAPER MAKING.

The Thames Paper Company Limited has carried out an experiment on the sea-weed that is to be found in the estuary of the Thames, and which is a fairly common type along the shores of this country. This was dealt with in the company's laboratory, and the chemist's report is given below. From this it will be observed that the fibre contents of this sea-weed is practically nil. It is probable, however, that the type of sea-weed suitable for this purpose is somewhat different, for companies have been formed in Italy and Japan for the purpose of exploiting sea-weed in this way. As the possibility of utilizing this raw material in the manufacture of paper is of great interest at the present time, further inquiries are being made into the question. The chemist's report referred to above is as follows:—Samples from the local foreshore have been carefully examined from the above stand-point—water content, 73.50 per cent (as received), bone-dry weight, 26.50 per cent. This latter was chiefly dirt and foreign matter, salt (sodium chloride and other haolgens), and colloidal substances akin to gelatin. The amount of fibre was practically negligible, and was extremely difficult to isolate on account of the "colloids." Cellulose was not worth estimation, and the sample was useless as a raw material for paper making.

BLIND TO THE FUTURE.

Although, more and more, the leaders of industry are awakening to the grave necessity of encouraging and fostering scientific industrial research, there is still blind opposition, or cold indifference, on the part of a large section of the public to further action in this direction. The *Chemical Age* draws attention to the short-sighted action of a section of shareholders in causing the withdrawal of an excellent proposal of the directors of Brunner, Mond, & Co. to distribute £100,000 among Universities, and other selected institutions, for the furtherance of scientific education and research. At the present time, perhaps more than at any other period in the history of the Empire, the maintenance of our old industries and the establishment of new ones depend upon an adequate supply of scientists and technologists. The fight for industrial supremacy will be won by the most efficient nation, and it is largely by public-spirited action on the part of successful business institutions that research and technology will be advanced. To rely solely upon Government institutions, particularly at a time when every Treasurer is at his wits' end to secure money for ordinary departmental activities, is stupidly optimistic. Professor Donnan, commenting upon this decision of the shareholders in Brunner, Mond, & Co., writes: "The financial exchange is heavily against Germany, but I do not think the intellectual exchange is against them. The present situation in the United Kingdom is well known to the far-sighted and able directors of Brunner, Mond, & Co., and it is very earnestly to be hoped that the shareholders of this great and deservedly famous company will support their directors in the splendid and pioneering action which they have desired to take."

GERMANY'S BROWN COAL DEPOSITS.

The annual report of the German Mineral Oil Co., states *The Chemical Age*, refers to the great success attained in the last three years in extracting lubricating and heating oils from brown coal. Large brown coal mines have been bought up with this aim, and as the annual output of brown coal is about 100,000,000 tons, and is rapidly increasing, it is calculated that Germany will ultimately be able to get along with very small imports of petroleum. The brown coal extraction process was known before the war, but was put into force first in 1916, when the shortage of lubrications threatened to stop the whole German war machine.

INDUSTRIAL CO-OPERATION IN AUSTRALIA.

Some months ago, the Institute of Science and Industry published a bulletin dealing with plans for welfare work in various parts of the world. Under the title of "Industrial Co-operation in Australia" a second bulletin has now been issued outlining purely local activities. Every effort was made to obtain particulars of all the schemes in operation, but it is possible that the whole field has not been covered. The range is sufficiently wide, however, to indicate the main features of the work, and from the replies received to the many inquiries that were made it is clearly apparent that a great deal of thought is being given to the question of improving the working conditions of employees

without increasing their tasks. In order to obtain the fullest possible information on the subject, letters were sent to about 100 firms, companies, and individual employers, as well as to Chambers of Commerce, Chambers of Manufactures, the Bankers' Institute, associations of employers, manufacturers, retailers, &c. The response was very satisfactory. Some difficulty was experienced in compiling and classifying the replies, for many of the schemes differ so materially that it was impossible to group them under general headings. It is hoped that in making this information available the Institute may be able to render some service to those who are seeking a solution of the complex problems which modern industrial organization is giving rise to. In Bulletin 15, the principles underlying the welfare movement generally were discussed. Bulletin 17 is, in a sense, complementary to the former, but it confines itself to descriptions of schemes actually in operation, the results of which are being followed with very wide interest.

WOOLLEN RESEARCH ASSOCIATION.

Of the many Research Associations approved by the Department of Scientific and Industrial Research in Great Britain, one of the largest is the Association for the Woollen and Worsted Industries. In a recent report of the council of that Association reference is made to the difficulty of obtaining first-rate research men, especially those men with experience in textiles. Owing to the small number of scientific men of high standing working for the advancement of the wool textile industry, it soon became clear that the Association would have to make its own experts. A similar difficulty is being experienced by practically all the Research Associations which have been formed, and this fact, perhaps more than any other, serves to emphasize the imperative necessity for industrial research. Industrial research was so neglected that suitable men are not available. The thoroughness with which the work has been commenced now that its importance has been realized augurs well for success. Preparations are being made, not with the frenzied zeal of the reformer, but deliberately and comprehensively, indicating that there is stability and permanence behind the movement. A final agreement has been entered into with the Government for the payment to the Association of £25,000 in respect of a period of five years, dating from September, 1918, provided that the Association raises at least £5,000 in each of these years. That amount has already been exceeded by subscriptions due from members. The Government have further agreed that for each additional £1 over and above £5,000, and not over £8,000, raised by the Association in any one year of the period, a sum of 10s. will be payable. For a sum over £8,000 a subsidy of 5s. will be payable; and, when the combined income from private and Government sources reaches £50,000, the rate of any further grant will be the subject of special negotiation. This amount may appear large to firms that have spent nothing on research work in the past; but, having regard to the magnitude of the industry, it is trifling. The Association points out that the large chemical firm of E. I. du Pont de Nemours Company, of Delaware, United States of America, estimated their expenditure upon research for the current year at £400,000, and stated that 866 chemists would be employed.

EMPIRE COTTON-GROWING COMMITTEE.—SCHEME OF ORGANIZATION.

During the interval which has elapsed since the publication of its report, the Empire Cotton-growing Committee has given consideration to the measures which ought to be taken to carry into effect the recommendations made therein. The more important of these recommendations were referred to in *Science and Industry* (Vol. 2, No. 3, p. 141), and included provision for pure research in such subjects as plant physiology, plant genetics, mycology, and entomology, and provision also for post-graduate studentships attached to these and other Chairs, by means of which promising men can be trained in methods of research.

The scheme of organization is being prepared in consultation with the Board of Trade. It is probable that a Board of Trustees will be incorporated under the Royal Charter to hold the funds available, and to release them as required by the administrative body. Research and education will be fostered and assisted, but the matter of most pressing importance, and which will absorb most of the money available, is the strengthening of the staffs of the Agricultural Departments of Colonies and Protectorates where cotton is a possible crop by adding to the staffs trained men, who will give their whole, or their main, attention to cotton. The efforts of the Agricultural Departments in several of the Colonies and Protectorates to introduce improved seed and to maintain purity of strains will be supported and extended. Means of transport will also be systematically studied. The immediate work of the Committee is to obtain the ratification of the 6d. levy by the two masters' federations and the two cotton associations, and to complete the technical details necessary to put it into force.

INSECT PARASITES—A SUCCESSFUL INVESTIGATION.

The Experiment Station of the Hawaiian Sugar Planters' Association has published a report entitled "Philippine Wasp Studies," which contains, among other things, particulars of the work undertaken with the definitely economic object of procuring natural enemies of the beetle *Anomala Orientalis,* which, by reason of the havoc wrought in the larval stages on the roots of the sugar-cane, is a serious pest in the plantations, and was causing heavy losses in the island of Oahu, Hawaii. The quest of the entomologists was entirely successful, and through their labours the foe appears to have been vanquished, with the result that a large saving has been effected of one of our most valuable articles of food. The ally which the entomologists summoned to the aid of the sugar planters was the "wasp" *Scolia Manilæ,* which is a small black and yellow insect which occurs abundantly in the Philippines. The females possess the power of detecting the presence of certain subterranean beetle grubs, and having located their victim, dig down to it and deposit on its ventral surface an egg, from which there soon emerges a larvæ that devours the beetle grub. It is stated that the wasps established themselves with such success, and increased so rapidly, that they are now more abundant near Honolulu than at their native place, while the pest *Anomala Orientalis* is vanishing so satisfactorily as to cause wonder how the wasp maintains itself.

EDITORIAL.

RESEARCH—WHAT IT IS NOT.

With the exception of a few devoted individuals (professors in universities, &c.), having many other claims and small resources, it may be said no research which has a direct bearing on the wool-textile industry has been carried out at all, excluding, that is, work on dyes. At the instance of the Woollen and Worsted Research Association, the Department of Scientific and Industrial Research called a conference on sheep breeding, and experiments are to be undertaken with a view to the improvement of locally-grown wool. From this basis the Association is building up a comprehensive scheme of research, including the collation of known facts, and fundamental or pure research. Under the heading "Research—What it is not," the Association, in its last annual report, warns its members against expecting the impossible from scientific investigation. It is pointed out that research is not a mere means of detecting and remedying technical faults. It is true that the methods of research may be of great value, say, in determining the cause of a faulty piece, but in 99 cases out of 100 such inquiries ultimately trace the fault to some error in procedure, a careless labourer, or fault in materials, such as bad oil. Often an inquiry of this kind is difficult and prolonged because the fault is of irregular occurrence; and, when finally traced, no advance in general knowledge is made. For this reason, although a consulting staff is being formed for the benefit of members, their time will have to be charged if special visits, analyses, &c., have to be made. Often such consulting work may suggest a line of research, or may bring to light some general and systematic error in trade practice. In such a case, the Association would, of course, bear the cost itself. The dividing line in these cases will be determined by the answer to the question—Is the matter new; does the solution advance general knowledge; is it of interest to the trade generally? Broadly speaking, however, this consulting work in itself is not research work. Research, also, is not a magic wand that may be waved and in a moment alter an industry. There has been a tendency in certain quarters to make wild and impossible promises that the trade will be revolutionized in a moment.

NATURAL GAS.

More than 2,100 cities and towns in the United States are supplied with natural gas. The average price per 1,000 cubic feet charged to domestic consumers in the United States, in 1917, was about 30 cents. The average price charged to manufacturers was less than 12 cents. The average price of artificial gas is $1 per thousand.

Most of the towns and cities supplied with natural gas are in New York, Pennsylvania, Ohio, West Virginia, Kansas, Oklahoma, and California. In Ohio, 872,000 domestic consumers were supplied in 1917; in Pennsylvania, 480,000; in California, 239,000; in Kansas, 188,000; in New York, 164,000; in West Virginia, 129,000; and in Oklahoma, 95,000. The industrial consumers, by whom the gas is used for manufactures or for generating power, use twice as much gas as the domestic consumers.

During the present century the value of the natural gas used in the United States has risen annually from $27,000,000 to $142,000,000. A report by John D. Northrop, just published by the United States Geological Survey, Department of the Interior, gives statistics of the production and consumption of natural gas, and sketches the condition of the industry in 25 States. It gives, also, statistics concerning gasoline made from natural gas in that year. The recovery of gasoline from this source has now become a large industry, which contributes materially to the supply of motor fuels. In 1911, there were in operation 176 plants, which produced about 7,400,000 gallons of raw gasoline from natural gas. In 1917 — only six years later — there were 886 plants, which produced nearly 218,000,000 gallons.

Prior to 1916 most of the gasoline recovered from natural gas was derived from casing-head gas obtained from oil wells by methods involving compression and condensation, but from year to year an increasingly large proportion of the annual output of natural-gas gasoline has been recovered by the absorption process.

SHEEP-FLY IN GREAT BRITAIN.

Among sheep-farmers in certain parts of Great Britain the blowfly pest is assuming large proportions, states the London *Times* of 9th June. In the past, a check has been kept upon it by reason of the fact that there was an adequate supply of farm labour. The *Times* states that—"The only method to prevent the fly 'striking' is by clipping the dirty wool, to keep the flock in a sanitary condition. With, perhaps, thousands of sheep on mountain grazings this means an immense amount of work, and it is becoming increasingly difficult to obtain fell shepherds, because lowlanders are unfitted for the work, and the young dalesmen migrate to take up less arduous employment. A fly-trapper could set and maintain traps on each sheep farm proportionally to stock and acreage. Although the blue-bottle (*Calliphora erythrocephala*), which invades the butcher's shop and the housewife's larder, is responsible for some of the stricken sheep, the greater number are victims of the green-bottle (*Lucilia sericata*), the true sheep-fly, which causes the poor animal to die an agonizing death. There are, therefore, strong compassionate, as well as financial, reasons why vigorous steps should be taken to reduce the plague. Thirty or 40 years ago, a Coniston gentleman invented an effective trap. It is baited with strongly smelling meat or carrion; the flies ascend an upward plane, and once inside never discover the aperture by which they entered. But shepherds were cheap in those days, and this, combined with the prejudices of the dalesmen, led to the neglect of a useful invention. Some of these traps are still in existence, and a few years ago the manager of the Manchester Corporation's Thirlmere Estate, after considerable trouble, secured one. Much of Lakeland has been converted into a gigantic reservoir, and fly-trapping would be a gain, not only to the pastoral industry, but to the public health, for the stricken sheep leaves the flock, and almost invariably dies in or near a stream."

EDITORIAL.

PAN-PACIFIC CONFERENCE.

The Australian scientists who attended the Pan-Pacific Conference at Honolulu have returned well satisfied with the work accomplished. Mr. E. C. Andrews, the Government Geologist of New South Wales, who was one of the delegates, stated that the aims of the Conference were embodied in a series of resolutions, which represented the views of the leading scientists of Australia, New Zealand, the Philippines, United States, Canada, and Japan. "The work," he said, "which these scientists have set themselves to accomplish has its roots in the individual efforts of famous observers in the Pacific; it is an extension of the great labours of Darwin and Dana on coral reefs and on volcanoes; also of Professors Sollas, David, and Alexander Agassiz, and of their disciples in the Pacific, whose efforts had been productive of a great gain in our knowledge of the Pacific. The Conference aims at co-ordination of work in the Pacific by numerous specialists in all branches of science, so that on the one hand the origin of the Pacific Islands, and of the continents on its margin, may be determined; and, on the other hand, that the economic possibilities of these lands may be known to the world." The Conference lasted three weeks during August, and the deliberations of the 110 delegates were held in the famous throne-room of the Kamchametha dynasty, and the speakers addressed the Conference from the royal dais. The Conference was convened by scientists of the United States, and the trustees of the Bishop Museum of Hawaii generously provided funds to defray the official expenses of the delegates. Honolulu was chosen as the meeting place, because of its being the cross-roads of the Pacific, being about 4,400 miles from Sydney, 4,700 miles from Panama, 2,100 miles from San Francisco, 2,300 miles from Vancouver, and about 3,000 miles from Japan.

X-Rays: A Brief Sketch of their History, Nature, and Technical Applications.

By PROFESSOR KERR GRANT, University of Adelaide.

The actual discovery of X-rays was made by William Röntgen, Professor of Physics in the University of Wurzburg, in the year 1895; a discovery not to be regarded as an isolated peak of scientific achievement but as the culmination of a long series of investigations into the phenomena accompanying the discharge of electricity through rarefied gases by many previous investigators.

Chief among the names of these earlier investigators are those of Faraday, Crookes, and Schuster in England; of Hittorf, Goldstein, and Lenard in Germany.

The nature of these antecedent discoveries may be briefly summarized: Air, or any other gas, at atmospheric pressure, and in its ordinary condition, does not permit of the passage of an electric discharge from an electrified conductor to an adjacent one unless the potential difference between the conductors amounts to some 75,000 volts for each inch of space separating them; if this voltage gradient be exceeded a discharge takes place in the form of an electric spark or series of sparks. If, however, the air or other gas is contained in a glass tube fitted with metal electrodes, and if the pressure of the gas within this tube be steadily lowered by means of any form of air-pump, the discharge is found to pass more and more readily, the necessary voltage falling in proportion to the decrease of pressure. Moreover, the character of the discharge changes greatly as rarefaction increases, the violent intermittent spark being gradually replaced by a silent continuous flow of electricity, the path of which is no longer confined to an extremely narrow band of air but includes, at pressures of 1 inch or less, all the gas between the electrodes, as is manifest by the luminosity displayed by the contents of the tube.

This luminosity, however, is not uniform along the length of the tube. The negative electrode, or kathode, is enveloped in a luminous mantle; this is succeeded by a space devoid of luminosity, the Faraday dark space, and this by a luminous column, sometimes striated in appearance, extending to the positive terminal or anode.

This is the general character of the appearance with pressures between 1 centimetre and 1 millimetre of mercury; with further reduction another dark space appears between the negative glow surrounding the kathode and the kathode itself. This is known as the "Crookes dark space."

As the vacuum becomes higher this latter dark space extends further and further outwards from the kathode, until it extends laterally to the walls of the tube and to the anode itself. Corresponding with this extension the luminosity of the gas falls off and becomes restricted to a beam or pencil proceeding outward from the kathode and suggestive in appearance of the track of a beam of sunlight through the dusty air of a darkened room. The colour of this pencil depends upon the nature of the rarefied gas; where it strikes the wall of the tube a bright green fluorescence of the glass is produced. As Crookes first showed, it carries sufficient energy to heat pieces of

metal foil on which it impinges to a white heat, or to cause motion in lightly-suspended objects. If a magnet be brought near the bulb it is deflected in the same manner as would be a flexible wire carrying an electric current.

The name "kathode rays" was applied to this peculiar radiation by Goldstein, and for long the nature of the kathode rays was hotly disputed. The old controversy concerning the nature of light, whether it be a corpuscular or a wave-motion, was fought over again, but the decision in this case was reversed. The rays were proved by Perrin and by J. J. Thomson to carry a charge of negative electricity. The charge and mass of the individual particles was determined by observation of the deflections they undergo in passing through an electric field of measured strength and through a magnetic field. (Figs. 1 and 2 illustrate these effects.) These magnitudes, charge

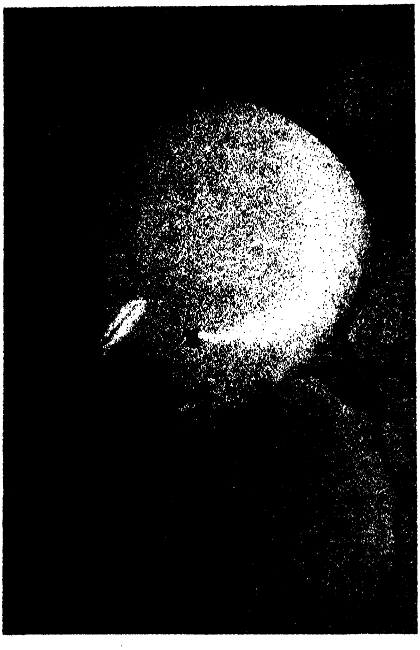


FIG. 1.—Deflection of beam of Kathode-rays by negatively charged metal plate. (From Sommerfeld's Atombau und Spektral-linien.)

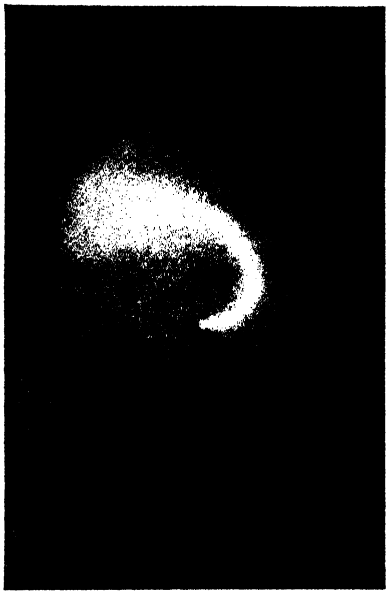


FIG. 2.—Curvature of beam of Kathode-rays due to magnetic field. (Ibid.)

and mass, and, what is more easily measured, their ratio, have been found to be always the same whatever the nature of the metal forming the electrode from which the rays emanate, and whatever the nature of the residual gas. The definiteness and invariability of these negatively-charged particles give them a unique importance in the most important scientific problem of the present day, viz., the problem of the electrical constitution of matter. A special name, "electron," has, therefore, been assigned to this entity.

The charge of an electron has been determined by a variety of means, and found identical with that carried by a hydrogen or other mono-valent ion in electrolysis; its mass is to that of a hydrogen atom as 1 to 1,850.

The electron manifests itself not only in the form of kathode rays, but in a great variety of other circumstances. Thus, the effect of a magnetic field upon the spectrum of the light emitted by a radiating gas, discovered by Zeeman in 1897, was explained by Lorentz on the hypothesis that the light is radiated by an electron rotating within the atom. The ratio charge : mass, determined spectroscopically, agrees with that found for the kathode rays. The positive electrification which electro-positive metals acquired when radiated by light of short wave-length (or by X-rays) is due to an ejection of electrons by their atoms; the same electrons are spontaneously ejected with enormous speed by the atoms of many radio-active substances; they also issue from metals when these are heated to very high temperatures; the process of gaseous ionisation has been shown to consist of the detachment or attachment of a single electron from or to the ionised atom; they can be shown to be concerned in the processes of metallic conduction and of optical dispersion.

In short, the electron declares its presence in every known kind of atom and in a great variety of conditions, and is certainly to be regarded as a universal constituent of matter.

The speed with which these electrified corpuscles travel depends solely on the voltage difference between kathode and anode; in other words, their kinetic energy is due to the electrical work done on them. Thus, with 100 volts difference they attain a speed of 8,400 kilometres (about 5,200 miles) per second; with 1,000, ten times this speed, and so on. At very high voltages and speeds, however, it would follow both from electrical theory and on more general grounds that the increase of speed with voltage should be less than at moderate velocities. Experiment has confirmed this view.

At high speeds the penetrating power of the kathode rays is considerable. Lenard, of Heidelberg, in 1893, made vacuum tubes with thin windows of aluminium foil, and, using high voltages, succeeded in making the rays penetrate these windows and emerge into the outside air. He thus was able to show that they exert a powerful photographic action, that they can excite fluorescence, and that they ionise the air through which they pass. His work is generally considered by German men of science as the immediate precursor of Röntgen's discovery.

X-rays are produced by the impact of the kathode rays on matter of any kind. (This statement is universally true only if the essential identity of X-rays and ordinary light be allowed.) In Röntgen's original experiment it was the walls of the bulb on which they impinged; in later types of tube a metal "anti-kathode" or "target" placed directly in the path of the beam of rays, which, moreover, can be focussed on this target by the simple device of making the kathode from which they radiate concave towards the target. For a given target the amount of X-radiation emitted is strictly proportional to the number of kathode rays which hit the target; the penetrating power depends both on the speed of the rays and on the material of which the target is composed.

The properties of X-rays were very systematically and thoroughly investigated by Röntgen himself. In almost all respects they resemble ordinary light so strongly as to suggest an essential similarity, if not identity. They affect, as does light, a photographic plate; they can excite fluorescence in certain materials, as can light; they ionise or render conductive air or

other gases, as does ultra-violet light; they have marked physiological effects analogous to "sun-burn." But they differ so markedly from ordinary light in their extraordinary power of penetrating opaque materials, and likewise in the impossibility of causing them to undergo reflection, refraction, or interference, that Röntgen himself left their nature an open question and signalised this mystery in the name he gave them.

Although continual accretions took place to the knowledge gained by Röntgen (and in particular the discoveries of Barkla that to each element used as a target a characteristic X-radiation pertained and that the rays, like light-waves, were susceptible of polarisation, must be mentioned), yet the real character of these radiations remained unproved, though not unguessed, until the year 1912. In that year Laue, Professor of Physics in the University of Munich, who in common perhaps with the majority of German physicists at the time held to the view that X-radiation was merely light of exceedingly short wave-length, conceived the brilliant idea of using the regularly-spaced arrangement of atoms in a crystal as a diffraction grating for X-rays, arguing that the relation of the atomic inter-spaces to their wave-length might be expected to be similar to that borne by the spaces between the lines of an ordinary grating to the wave-length of light. Experiments completely verified this conjecture. (V. Fig. 3.)

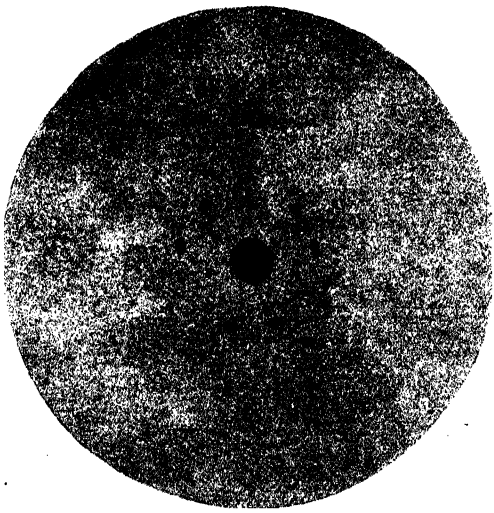


FIG. 3.—Diffraction of beam of X-rays by passage through crystalline plate. The central spot marks the incidence of the direct beam, the three pairs of spots are its diffraction images. (From the original by Laue, Friedrich, and Knipping.)

Laue himself used the crystal as a transmission-grating. W. L. Bragg showed that it could be used to better purpose as a reflection-grating, and in the hands of the Braggs (father and son), or Moseley, and of other investigators this new method of investigation speedily produced a vast increase in our knowledge of the X-rays themselves on the one hand, and on the other hand, of the arrangement of atoms in crystals. Barkla's

"characteristic radiations" were studied and their wave-lengths measured by Moseley working in the laboratory of Sir Ernest Rutherford in Manchester. Moseley showed that there is a steady shortening of wave-length as we pass from one element to the next higher in the periodic table, and that according to a remarkably simple law (v. Fig. 4), the differences of the square roots of the characteristic frequencies remain constant between each successive pair of elements. From this law it is easy to show that between the first element of the table—Hydrogen—and the last—Uranium—there remain yet undiscovered five elements and five only. Moseley also confirmed Barkla's discovery that elements of high atomic weight, at least, possess not one only but two characteristic radiations (the so-called K and L radiations). Later

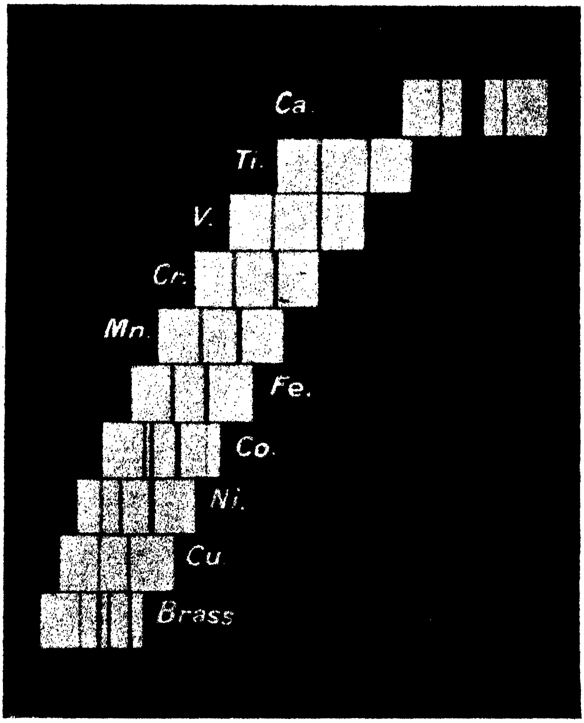


FIG. 4.—Moseley's spectra of X-rays (principal K and L lines), from different metals, showing progressive change of wave length.

investigators have added a third, the M-radiation. These three types of X-radiations show a progressively increasing wave-length, and consequently decreasing power of penetration. Thus the wave-lengths of the strongest line in the K-radiation from tungsten is .212 Angstrom (one Angstrom = one ten-thousandth of a metre; the wave-length of yellow sodium light is 5,890 Angstroms); that of the L-radiation 1.67 Angstroms; that of the M-radiation 7.01 Angstroms. The wave-lengths for other elements vary correspondingly. The K, L, and M radiations are not strictly monochromatic,

i.e., of one single wave-length, but consist of groups of such radiations differing slightly in wave-length. Thus the K-radiation contains four such groups, the L a greater number.

For elements of low atomic weight these radiations merge into ultra-violet or even into visible light.

The great interest of these results for the X-ray technician lies in the substitution of a precise and definitely measurable magnitude, the wave-length, for a relatively indefinite one, the "hardness" or penetrating power, and further in the possibility which is afforded of analyzing precisely the quality of the radiation emitted by the target, or anti-kathode. It is found, in fact, that the radiation from the target resembles the light emitted from an incandescent vapour, say, a mercury-vapour lamp, insomuch as a general radiation corresponding to "white" light is superposed upon the almost monochromatic radiation characteristic of the atomic species of the target corresponding to the "bright-line" spectrum of the metallic vapour. Fig. 5 shows the distribution of energy in the spectrum of the X-radiation from a tungsten target operated with 110 kilovolts between the terminals of the tube.

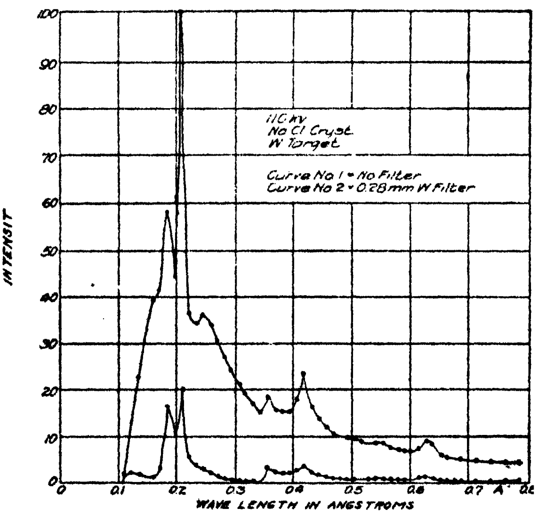


FIG. 5.—Distribution of energy in the spectrum of the X-radiation from a tungsten target. (*A. W. Hull Physical Review*, 1917.)

A simple and important relation has been found to exist between the shortest wave-length occurring in the radiation and the voltage applied to the bulb, viz.: that this wave-length decreases in exact proportion as the voltage increases. Similarly, unless the applied voltage reach the value corresponding to the wave-length of the characteristic radiation, that radiation will not be excited. As an instance, the K-radiation of tungsten requires an applied voltage of 67 kilovolts, the L-radiation about one-eighth of this, and so on. The long-known relation existing between the spark-gap of the coil and the "hardness" of the rays from a bulb is thus explained and made precise.

Ordinary radiography depends entirely upon the difference in absorbing powers of different materials. It was found by Röntgen himself and confirmed by later observers that this absorption increased with the density of the material. More precisely, the absorption by any elementary substance is proportional to the number of atoms penetrated and to the cube of the number which gives the place of that element in the periodic system. Thus an atom of calcium, the twentieth element, absorbs $(20/8)^3 =$ sixteen times as much as an atom of oxygen, place 8. It is for this reason, *e.g.*, that lead is so much employed for protective screening in X-ray work. This absorption is due to two main causes: firstly, a part of the radiation is used up in exciting the characteristic or "fluorescent" radiation of the absorbing element, and secondly a certain fraction is scattered or diffused in a manner similar to that in which the sun's radiation is scattered in passing through the earth's atmosphere. Now fluorescent radiation can be excited only by radiation of wave-length shorter than its own. Hence a curious irregularity appears in the relation between absorption and wave-length of radiation. If we start with a wave-length considerably below that characteristic of the absorber, and gradually proceed to shorter and shorter wave-lengths, the penetration as we would naturally expect will steadily and very rapidly increase, the fraction absorbed as rapidly decrease. But so soon as the wave-length of the radiation is diminished to that at which the characteristic radiation of the absorbing substance is produced, a large increase in absorption occurs. This fact is of importance to the radiographer, for photographic action is dependent upon absorption of the radiation by the sensitised emulsion, and it is seen that we do not necessarily secure greater effect by using a softer radiation. Fig. 6 illustrates the increase in photographic action occurring when the wave-length becomes short enough to excite the characteristic radiation of silver.

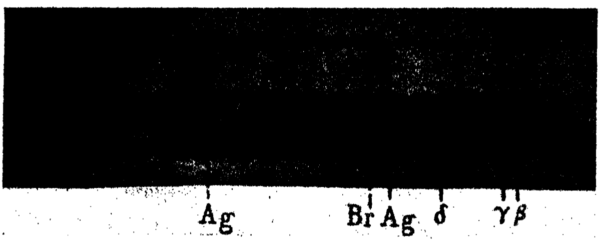


FIG. 6.—Spectrum of X-rays, showing sudden increase of absorption at a point where the fluorescent radiations of silver and of bromine in the photographic emulsion are excited.

This fact of greatly increased absorption at a certain critical wave-length can be made use of to secure a radiation in which one particular wave-length greatly predominates over all others. If, for example, the radiation from a tungsten tube operated at eighty to ninety thousand volts or higher, and producing strongly the characteristic K-radiation of tungsten of wave-length .212A., be passed through a filter of ytterbium or any compound of this element of properly calculated thickness, the radiation thus "filtered" is one in which the characteristic radiation of tungsten amounts to a very

large percentage of the total radiation. (V. Fig. 7.) For ytterbium w absorb strongly not only all long wave-length radiation but also all shorte than that of Angstrom units for which wave-length its own characteristic radiation is excited. Hence the continuous part of the X-ray spectrum is sharply limited on the short-wave side of the characteristic radiation by the selective absorption of ytterbium and also reduced by general absorption as the longer wave-lengths are approached.

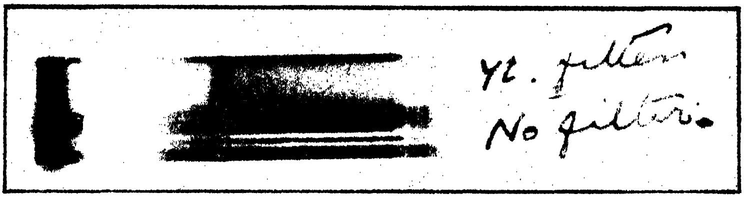


FIG. 7.—Spectrum of X-rays from tungsten, showing effect of ytterbium filter in producing nearly monochromatic radiation.

In radio-therapy the use of a homogeneous beam of X-rays is much to be desired. For the treatment of deep-seated tumours, in especial, it is obviously necessary to have radiation of sufficient penetration, and this radiation should not be mixed with too large a proportion of soft radiation, which would act injuriously upon the more superficial tissues. At present the practice of radio-therapists is to operate the tube with a long spark-gap, *i.e.*, high voltage, thus securing the requisite penetrating quality, and to cut down the amount of softer rays by "filtering," through suitable thicknesses of aluminium, a metal whose region of K-selective absorption lies in the extreme long-wave part of the spectrum, and which, therefore, exercises only a general absorption which is much greater for the softer than for the harder rays.

By the use of different metals in the target and selectively absorbing filters we have seen that much more truly monochromatic radiations might be obtained; whether the advantages to be thus gained will outweigh the practical difficulties yet remains to be seen.

We turn now to the consideration of an important development in the technics of X-ray production. It has long been known that an electrically-insulated piece of metal loses a charge of electricity, particularly a negative charge, much more rapidly if its temperature be at or above a red-heat than it does at ordinary temperatures. This effect had been traced to a spontaneous emission of electrons by the hot metal. Edison discovered that a piece of insulated metal plate or wire enclosed in a vacuum tube thus became negatively electrified, and his discovery was turned to good account by Fleming in the vacuum-valve used in its later forms so widely for the reception of wireless signals. Whether this property of electronic emission depended on the metal alone or on the chemical action of residual gases upon it was, until comparatively recently, a matter of dispute. The verdict of physicists both in Europe and in America was probably inclined to the chemical explanation, when Dr. Irving Langmuir, of the Research Laboratory of the General Electric Co., U.S.A., took up the matter on its experimental side, and, using the unrivalled facilities which the laboratory offered for the production of the highest vacua, succeeded in establishing beyond

question the fact of an electron emission independent of all causes except the nature of the metal and its temperature. His work made clear, also, the importance of a factor which had been overlooked by previous workers, viz.: the existence of a back-pressure or electromotive force due to the swarm of electrons surrounding the heated wire and tending to prevent the issue of further electrons. Just in the same way the drying of a wet string in still air would be retarded by the presence around the string of an atmosphere of water-vapour. And just as a current of air sweeps away this vapour and allows fresh vapour to issue, so does an electric field sweep away the electrons and allow a fresh swarm to take their place.

Langmuir showed that, under proper conditions, exceedingly large currents could be obtained from an incandescent filament of tungsten at temperatures approaching its melting point (3,100° C.). The following table indicates the relation between electron emission and temperature :—

TABLE I.

Electron Emission from pure Tungsten.

Absolute Temperature.	Amperes per sq. cm.
1,500°	0.58×10^{-6}
1,800°	$214. \times 10^{-6}$
2,100°	.00151
2,400°	0.13177
2,700°	4.35
3,000°	31.7

While Langmuir was pursuing this research his colleague in the same laboratory, Dr. W. D. Coolidge, was simultaneously occupied with an inquiry into the characteristics and limitations of the ordinary X-ray bulb, in especial, with the attempt to use tungsten in place of platinum for the anti-kathode. He had come, in the course of this research, to the reluctant conclusion that no modification of this type of bulb was possible which would very materially increase its output without, at the same time, rendering the bulb unstable in operation. Langmuir's results gave him a new inspiration. He saw the possibility of utilizing a pure electron current in the highest obtainable vacuum in place of the kathode rays of the older type of tube resulting from the impact of positive ions on the kathode. From the outset success appeared certain, and in less than a year from the first attempt at construction the first Coolidge X-ray bulbs were placed on the market. The construction of the tube may briefly be described : The source of the electrons is a small flat spiral of tungsten wire heated by a small storage-battery or from the low-voltage winding of a small transformer. Its temperature is thus controllable by means of a variable resistance and ammeter in this circuit, a range of from four to six amperes varies the temperature from a dull red heat at which electron emission just begins to a bright white heat at which it is extremely copious. The anti-kathode or target (which is also the anode) is of tungsten either in the form of a solid forged block with plane face opposed to the filament or of copper in which a button of tungsten is centrally embedded. The tungsten spiral forming the kathode is centrally situated in a shallow cylindrical cup of molybdenum sheet metal forming part of a larger electrode, the whole being so designed as to focus the kathode stream of electrons on the face of the anti-kathode. The voltage is supplied

as for ordinary bulbs by an induction coil or high-tension transformer. The earliest forms of bulb were very similar in size and shape to those used for the earlier type of X-ray tube. In later types of Coolidge tube considerable modifications have been introduced.

In order that the highest degree of vacuum—the air remaining after exhaustion must be less than one hundred millionth of that occupying the bulb at atmospheric pressure—may be not only attained but also maintained under the most severe conditions of operation, the bulb and its internal metal fittings are subjected to an extraordinarily thorough process of treatment and evacuation. The main difficulty in maintaining such an extremely high vacuum in a glass bulb containing metal parts arises from the circumstance that both glass and metal occlude air and other gases. This occluded gas is not released, or is released only in part by the mere process of evacuation, however thorough, but would be set free to a greater and greater extent as the tube becomes heated during operation, thus destroying the vacuum and making the tube inefficient, if not inoperable. To get rid of this occluded gas the bulb during the process of evacuation is contained within an electrically-heated oven maintained at a temperature of 360° C. or even higher, this high temperature having the effect of promoting the escape of occluded gas from the inner surface of the glass. After high vacuum has been attained the metal parts are intermittently subjected to bombardment by electrons and thus raised to a bright red heat. It is for this reason that the metals tungsten and molybdenum are employed in construction, both of these metals having exceedingly high melting points.

During the later stages of exhaustion the bulb is operated intermittently with increasing filament-current and increasing voltage between anode and kathode, the effect of this being to raise the temperature of the massive tungsten target to a bright white heat.

The action of the older types of X-ray bulb is accompanied by a bright green fluorescence of the glass. This phenomenon, in fact, is often looked upon as a criterion of good operation. It is, however, a secondary effect due to radiation from the residual gas, and hence is entirely absent in a good Coolidge tube. The operator who is in charge of the tube during the process of exhaustion can indeed gauge the progress toward its final stage by observing the gradual diminution of fluorescence of the wall of the bulb.

When finally exhausted the vacuum is so good that no discharge can be forced through the bulb with the highest attainable voltages unless the filament is heated to a temperature at which it emits electrons; and unless the discharge is so heavy as to actually volatilize the metal of the target the current is entirely undirectional. The Coolidge tube is thus a perfect rectifier of alternating current at any voltage. Inverse current, the *bête noire* of the ordinary bulb, is thus entirely eliminated. The primary and all-important advantage which the Coolidge or thermionic X-ray tube possesses over its predecessors, however, is the separate and precise controllability of the current through the bulb and of the voltage applied to the bulb. The former is controlled entirely by the temperature of the filament, which again depends on the current sent through the filament; the latter is controlled by the voltage across the terminals of the induction coil on high-tension transformer. It is thus possible to have either a very copious X-radiation of low penetrating power or a relatively feeble one of very high penetrating power, a fact of the utmost importance both in radiography and in radiotherapy. In the older ionisation type of bulb, on the contrary, the radiation

can be increased in quantity only by increasing the voltage applied between anode and kathode, with consequent increase in the hardness of the radiation, and, moreover, the voltage between the electrodes is limited by the amount of gas remaining in the bulb. The currents actually used in practice with Coolidge bulbs may range from 1 to 100 milli-amperes, the voltages from 20,000 to 100,000 volts. Of course, the extreme values both of current and voltage are used only in special circumstances, but the limitation to magnitude of current results rather from the volatilization of the kathode which would ensue were the tube operated for any length of time with currents of the order of 100 milli-amperes than from an insufficiency of electron supply from the hot kathode. The space-charge effect may also limit the current, particularly at low voltages.

It is possible by using a hollow target kept cool by a continual flow of water through its interior to obtain outputs very greatly exceeding the values just mentioned. Water-cooling, however, though possible in an experimental laboratory, is troublesome and uncertain in practical radiography, and in a recent type of bulb Dr. Coolidge attains the same end of dissipating the heat energy due to the bombardment of the anti-kathode by attaching it to a massive copper stem through which the heat is conducted to an external radiator. The anti-kathode itself consists of a tungsten button embedded in copper. The size of the bulb can consequently be greatly reduced, the latest type being approximately 2 inches in diameter and 10 inches in length. The Coolidge bulb has other and not unimportant advantages over the ionisation bulb, given a suitable generator of high-tension currents. Its wide range in performance enables it to be applied with equal success to a wide variety of cases in radiography or radio-therapy. It shows none of the capriciousness of the ionisation bulb which is so often the despair of its operator, and it will stand up to far heavier and more continuous work than will the ionisation bulb.

How well it has commended itself to the medical profession is shown by the fact that from the first sale in 1913 to August, 1919, no less than 25,000 of the bulbs had been sold by the General Electric Company.

Though the application of X-rays to radiography of the human body for the purpose of medical diagnosis and to radio-therapy still remains and may perhaps always remain supreme in practical importance, a number of other fields of application are coming to light. Firstly, radiography of materials and structures is being utilized to a continually increasing extent. Thus the detection of flaws, blow-holes, &c. in castings or weldings of not too great thickness is possible by radiography. The accompanying illustrations (Figs. 8 and 9) show better than words can do the measure of success attained. It may be stated that for thicknesses up to 1 inch the method is both practicable and satisfactory. For greater thicknesses success will depend upon the nature of the specimen and of the flaws to be examined on the one hand and on the voltage which can be applied to the bulb on the other. Although Sir Robert Hadfield, the well-known English ironmaster, a pioneer and enthusiast in this field, predicts that it will eventually be possible to satisfactorily examine castings up to 9 inches in diameter, it must be pointed out that the difficulties both in operating a bulb at the high voltage necessary to secure the requisite penetration for such large thicknesses of iron, and of securing photographs which are not completely "fogged" by the radiation scattered by such a mass of

material, become extremely serious. The time of exposure must also be increased to an extent which makes the taking of such radiographs both tedious and expensive.

FIG. 8.—Radiograph of Steel Casting, showing large flaw. (*Davey General Electric Review, 1915.*)

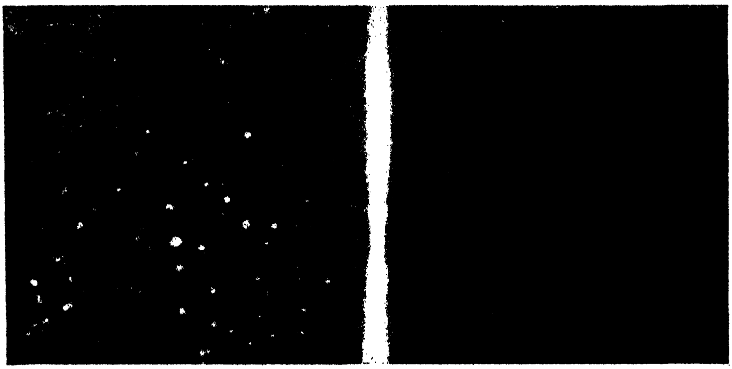


FIG. 9.—Radiograph of a block of pure copper (left) side by side with a block of "Boronised" copper (right). (Ibid.)

Very convenient methods of chemical analysis can be based either upon the existence of characteristic absorption, or upon that of characteristic radiation. It is only necessary to photograph the spectrum of the X-rays produced by the substance as radiator in the one or as absorber in the other case. The position of a "bright line" in the spectrum in the one case or of a definitely placed absorption-band in the other indicates unequivocally the presence of atoms of a particular species, and that irrespective of the presence of other atoms of different species.

A beautiful method of chemical analysis applicable to all crystalline substances has been developed by A. W. Hull, of the General Electric Research Laboratory. A narrow beam of approximately monochromatic

X-rays, obtained as explained above by filtering, is passed through the specimen in the form of a fine powder. The effect of the regular arrangement of the atoms in crystals is to reflect this beam at certain definite angles characteristic of the crystalline substance and peculiar to it alone. These reflected beams along with the direct beam can be received upon a photographic film or plate and the angles of reflection thus determined. One determination of the substance having thus been made and recorded, its occurrence or non-occurrence in any sample of material can thus be ascertained by taking a single radiograph of the substance in question. Some characteristic spectra obtained by Hull in this way are shown in Fig. 10.

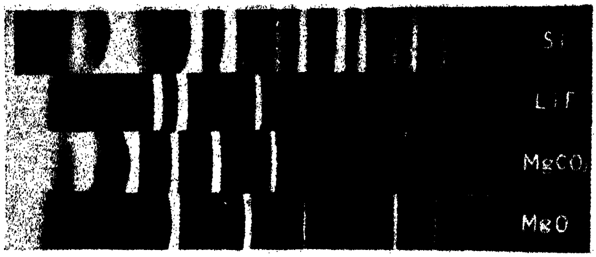


FIG. 10.—Typical X-ray Powder Patterns.

This method promises to be a valuable aid to ordinary chemical analysis in cases where it does not supplant it altogether. It has the great advantage over the latter method that the analysis is made on the material in its actual physical and chemical condition. Thus an analysis of a finely-powdered mixture of sodium chloride and potassium nitrate by chemical means, which implies dissolving the material and breaking down the crystals, can give only the percentages of metals and negative radicals, not the manner of combination. Hull's method, however, reveals definitely the actual compounds existing in the mixture. It seems likely that in the metallurgy of alloys, in ceramics, and other technical arts this method has an important future.

Coal Economy.

By GERALD LIGHTFOOT, M.A.

1. GENERAL.

In his recent work on "Coal and its Scientific Uses," Professor W. A. Bone, F.R.S., the eminent British fuel technologist, quotes the following passage from Jevons :—

Coal in truth stands not beside, but entirely above, all other commodities. It is the material source of the energy of the country—the universal aid—the factor in everything we do. With coal almost any feat is possible or easy; without it we are thrown back into the laborious poverty of early times. . . . . The progress of science, and the improvement in the arts, will tend to increase the supremacy of steam and coal.—(W. Stanley Jevons, on "The Coal Question," 1865.)

More than 50 years ago, Jevons endeavoured to awaken public opinion in England to the vital importance of the coal question to the industrial future of the nation. To-day it is generally accepted that one of the main sources of industrial prosperity of the leading nations of the world has been an abundant supply of good and cheap coal. It has not, however, been so generally recognised that the abundance and cheapness of these supplies have been the very causes which have led to the almost universal reckless extravagance in their use—in Australia no less than in any other country. It has been stated that Great Britain alone loses by-products from her coal to the value of £200,000,000 per annum, and that if the existing wasteful methods were replaced by the most economic means of consumption, not only would she be able to manufacture sufficient motor spirit to fill her own requirements, but would also obtain large quantities of sulphate of ammonia and other chemicals which form the basis for the manufacture of explosives, dyes, and a large number of chemicals and drugs.

In Australia the annual consumption of coal is approximately 9 million tons. Efforts have been made to obtain information as to the general purposes for which this coal is used, but particulars as to the quantities used for domestic purposes and in manufacturing industries are not available. The following statement, however, furnishes some interesting information on this point :—

Consumption of Coal in Australia, 1917.

	Tons.
1. Gas Works	900,000
2. Electric Generating Stations	680,000
3. Manufacture of coke	600,000
4. Railways—	
(a) Locomotives	2,210,000
(b) Other purposes	260,000
5. Other purposes*	4,370,000
	9,020,000

* Including bunker coal for Inter-State and coastal vessels, manufacturing industries, domestic uses, and all other purposes.

These figures show that only 1,500,000 tons, that is, one-sixth of the coal used in Australia, is at present "carbonized," *i.e.*, 900,000 tons in gas works and 600,000 tons in coke ovens. The coal used for these purposes, as will appear later, is carbonized at relatively high temperatures. In the one case the primary object of the process is, of course, the production of gas, and in the other, the manufacture of coke, and while the processes are conducted to attain these respective objects, the by-products can be saved, though at the present time in Australia they are very largely wasted. The remainder of the coal used in Australia is burnt simply for the purpose of generating heat, either under boilers or in some other manner, and a large proportion of the available heat-units as well as valuable by-products are entirely wasted. Even in large modern steam generating plants, burning coal under boilers in the usual way, the maximum thermal efficiency of the steam generators does not exceed about 80 per cent. That is to say, one-fifth of the potential value of the coal is wasted. A recent examination of 1,000 boilers in England gave an average thermal efficiency of only 57 per cent., and no fewer than 300 of them had an efficiency of less than 50 per cent. It is obvious, therefore, that present methods are exceedingly wasteful, not merely by reason of the loss of the by-products, but also in respect to the available heat-units wasted.

In various countries, notably in England and America, a great deal of attention has recently been paid to what are known as processes for the "low-temperature carbonization" of coal. The object of these processes is to devise a commercial method of carbonizing coal in such a way that the valuable by-products, available for the purpose of nitrogenous fertilizers, crude oils, motor-spirit, and oils for marine propulsion, can be saved and the "carbonized" residue used as a smokeless fuel, either for the generation of electricity at large central power stations or for domestic purposes. The problem of establishing an efficient process on a commercial scale has not yet been solved, but it is considered that there is little doubt that satisfactory processes will be evolved before long. Investigations have made it clear not only that different temperatures and processes of distillation, but also that different types and even different seams of coal give quite different results in the nature, qualities, and yields of by-products.

Industrial development in Australia, as in other countries, will be greatly affected by the cost at which power can be supplied in the form of electricity. In this country we have neither water-power nor natural oil or gas in any appreciable quantity, and the problem of the economical production of electric power from coal is therefore of special importance. The cost of producing power from coal could be substantially reduced by the establishment of large central stations, where, instead of burning the coal directly under steam boilers, it would be first subjected to carbonization and gasification processes, which in addition to fuel gas would yield valuable by-products. It is obvious, therefore, that the question of low-temperature carbonization is of the highest importance in this country. For instance, there is the case of Collie (W.A.) coal, which is not suitable for bunkering coal, owing to its liability to spontaneous combustion. If the necessary investigations were carried out this coal might be carbonized and a satisfactory steaming coal obtained, in addition to valuable by-products. Again, there is the problem of the economic utilization of Newcastle and Maitland coal. At present a small fleet of steamers and numerous railway waggons and locomotives are engaged in transporting coal at great cost from Newcastle to various indus-

trial centres of the Commonwealth. When it is burnt, a large proportion of the heat-units, as well as highly valuable by-products, are wasted. If the problem of the economic utilization of fuel could be solved, a large proportion of the Newcastle coal would be carbonized in the vicinity of production, the volatile by-products would be available for motor fuels and other purposes, and the carbonized residue partly burned for the generation of electrical energy for long-distance and local distribution in New South Wales and partly transported as a smokeless fuel for domestic purposes. In Victoria, the efficient development of the immense deposits of brown coal, and the recovery of the by-products, should eventually render that State independent of coal from New South Wales, and, possibly, to a large extent independent also of imported liquid fuels.

Those who, by knowledge, experience, and practice are best qualified to judge, hesitate to prophesy as to what the economic possibilities of combined carbonization and power-generating schemes will be, but they agree that the interests at stake are so great that the question ought to be thoroughly investigated and authoritatively answered. For the purpose of investigating the whole question, so far as British coals are concerned, in a comprehensive and systematic manner, a Fuel Research Board was established in England about three years ago by the Department of Scientific and Industrial Research. A valuable and informative Report on the subject has just been issued by that Board, and it contains references to a number of matters of great national, scientific, and commercial interest. The Board was constituted in 1917 at a time when the country's fuel situation, particularly in the matter of the supply of fuel oil to the Navy, was giving rise to considerable anxiety. The Board, however, was not brought into existence to fulfil the temporary need incidental to the war, but was intended to exhaustively study the question of fuel resources and how they could be used on a more economical basis and with increased efficiency.

About eighteen months ago the Commonwealth Institute of Science and Industry appointed an influential and representative committee to inquire into the whole subject of Coal Economy in Australia and to make recommendations as to what research work should be initiated. At that time it was expected that the permanent Institute would have been established at an early date. No funds, were, however, available for the purposes of the Committee, and little progress has been made, though a considerable amount of preliminary information and data has been collected. The following are the names of the members of the Committee :—

COMMONWEALTH FUEL ECONOMY COMMITTEE.

Mr. V. G. Anderson ..	Messrs. Avery and Anderson, Research Chemists, Melbourne.
Mr. D. Avery	Messrs. Avery and Anderson, Research Chemists, Melbourne.
Mr. R. Boan	Testing Branch, Victorian Railways Department.
Mr. C. F. Courtney ..	Sulphide Corporation, New South Wales.
Mr. Colin Fraser ..	Broken Hill Associated Smelters.
Mr. H. W. Gepp ..	Electrolytic Zinc Company Ltd.
Mr. E. P. Grove ..	Messrs. Merz and McLennan, Melbourne.
Mr. Essington Lewis ..	Broken Hill Pty. Ltd.
Mr. A. A. Macintosh ..	Metropolitan Gas Co., Melbourne
Mr. G. W. Turner ..	Messrs. Howard Smith Ltd., Melbourne.

2. DESTRUCTIVE DISTILLATION OF COAL.

When a solid or a liquid is converted into vapour by the application of heat and the vapour is then condensed by cooling, the process is called one of "distillation." If the body which is distilled decomposes at the temperature necessary to convert it into a gas, so that the products cannot be again condensed into the original substance, it is termed "destructive distillation." The effect of heat upon coal is to decompose it into the solids which remain behind in the retort, the liquids which are condensed, and the gaseous products.

When an ordinary gas coal is subjected to destructive distillation, the volume of the gas, its heating and illuminating value, and also the quality and quantity of the tar are subject to great variations, according to the temperature at which the distillation is carried out. The following table shows the average results that may be obtained with a good sample of gas coal. In addition to the tar, the distillates include an upper aqueous portion containing ammonia in solution from which the ammonium salts of commerce are obtained.

AVERAGE YIELDS OF GAS AND TAR PER TON OF COAL CARBONIZED.*

Temperature of Distillation.		Volume of Gas.	Tar.	Specific Gravity of Tar.
C.	F.	Cub. Ft.	Gals.	
00	1,652	11,000	9	1.200
00	1,472	10,000	12	1.170
00	1,292	9,000	15	1.140
00	1,112	7,750	18	1.115
00	932	6,400	21	1.087
00	752	5,000	23	1.060

* See "The Carbonization of Coal," by Prof. V. B. Lewes, London, Benn Bros., 1918, p. 122.

Not only is there a great variation in the quantities of gas and tar yielded at different temperatures, but their composition also varies greatly. Thus the percentage of hydrogen in the gases obtained in the above experiments ranged from 21.2 at the lowest temperature to 54.5 at the highest. Similarly the nature of the tar varies greatly, as is seen from the difference in the specific gravities. Broadly speaking, high-temperature carbonization gives high yields of gas and aromatic oils (benzene, &c.), while lower temperatures result in a smaller amount of gas and a larger proportion of tar yielding light oils (paraffins, &c.). This statement is, however, subject to qualifications respecting recent developments in low-temperature carbonization processes referred to hereinafter. When coal tar is distilled, different distillates pass over within certain definite temperature limits, as is shown in the following statement :—

COAL TAR DISTILLATES.

Temperature.	Distillates.
0°–170° C.	Light oils.
170°–230° C.	Middle oils.
230°–270° C.	Creosote oils.
Above 270° C.	Anthracene oils.

Residue—pitch (soft, medium, or hard, according to the extent to which the anthracene oils have been distilled).

It will be seen that the light oils first pass over, from which benzene can be obtained. Benzene is of wide industrial use. It is the source from which anilin is prepared, and it is from anilin that most of the coal tar colours are obtained. On fractional distillation the light oils, after treatment, yield refined benzol, for use as a motor fuel, and solvent naphtha, with a certain amount of phenol and pyridine bases. The middle oils pass over next. They are rich in phenols and are of value for the manufacture of naphthalene, carbolic acid, and other chemicals, especially disinfectants. The creosote oils distil over between 230° and 270° C., and are largely used, for example, for treating timber, such as railway sleepers, for preservation purposes. The fraction distilling above 270° C. is called "anthracene oil," and is the starting point from which the series of alizarin colours is derived. The residual pitch is used for various industrial purposes, *e,g.*, in the artificial asphalt industry, in the manufacture of coal briquettes, &c. There is a large but somewhat irregular demand for it.

The utilization of coal by methods of destructive distillation may be effective in three different ways, which are differentiated from one another by the primary products obtained. The three methods are :—

(*a*) High-temperature carbonization, as carried out at gas works in horizontal or vertical retorts at temperatures ranging from 1,000° to 1,300° C.

(*b*) High-temperature carbonization, as carried out at coke works at temperatures from 1,200° to 1,300° C.

(*c*) Low-temperature carbonization.

The primary product of the first process—(*a*)—is a high calorific value gas, largely used as an illuminating gas, but now increasingly used for fuel and power purposes, and ordinarily known as coal gas. The residual coke, as well as the tar and ammonia by-products, are the secondary yields in this particular mode of carbonization. In Australia, the ammoniacal liquors from gas works are generally saved, but the tar is not ordinarily distilled beyond the first stage, the main products being refined tar for road-making purposes and benzol. In the existing stage of the chemical industry in Australia, it would not ordinarily pay to go beyond the first stage in the distillation of tar, as it is not economical to work up the various products except in very large quantities. Modern developments in the gas industry are in the direction of obtaining the highest possible proportion of the total thermal units in the coal in the form of gas for distribution to consumers. No development of the gas industry on the lines of the present process of carbonization is, therefore, likely to help very materially in the production of fuel oils. Well-recognised uses exist for the by-products of the gas industry, and it may fairly be expected that the extension of the chemical industry in Australia will result in the utilization of these products along natural lines of development.

In the second high-temperature process—(*b*)—the operation is conducted to obtain the hard firm coke required in metallurgical processes, as for example, in the smelting of iron. Considerable quantities of coke oven gas are also obtained, and this is used partly to provide the heat required for carbonization. The surplus gas can be used for much the same purposes as coal gas.

Originally, coke was produced by the combustion of coal in limited supplies of air in stacks or piles, as in the process which is still used for the production of wood charcoal. The extraordinary wastefulness of such a procedure led to the first improvement—the coking of coal in beehive ovens in which the volatile distillation products were burned in the dome of the oven. The wastefulness in this process lies in—(*a*) the combustion of valuable products of distillation left in the coke oven gas, and (*b*) the loss of coke substance due to the simultaneous combustion of part of the coke first produced in the upper layers of the charge. The obvious development of withdrawing the gaseous products from the oven to be mixed with air for combustion on the outside of the oven was next introduced. There still remained, however, in this type of oven, the losses due to combustion of by-products and of more gas than was necessary for the maintenance of the carbonization process. The modern practice is to use ovens in which the gases, prior to combustion, are subjected to a system of by-product recovery whereby tar, ammonium sulphate, and benzol are removed from the gases, which are then burned around the oven and passed for waste heat utilization to the boiler plant.

In Australia, up to about two years ago, the whole of the coke was made in beehive ovens. Recently a number of by-product recovery ovens have been installed, but the gases from these ovens are not " stripped " for benzol. The question of the installation of up-to-date by-product recovery ovens is now receiving the attention of several large industrial enterprises in Australia. The New South Wales Government proposes to make the installation of by-product recovery ovens compulsory in the coke-making industry in that State.

It is probable that the quantity of coal used in the coking industry in Australia will reach 1,000,000 tons per annum in the near future, so that if all our coke ovens were equipped for the recovery of benzol, we might expect to obtain about 3,000,000 gallons of benzol annually, that is about one-seventh of our total present petrol requirements.

The third method—(*c*)—is the low-temperature process of carbonization, the primary objects of which are the production of a free-burning smokeless solid fuel, suitable for purposes of domestic heating and steam generation, and a high yield of liquid fuels. Simultaneous solution of the smoke and air pollution problems, so far as domestic fuel consumption is concerned, would result from the successful production of such a fuel.

3. LOW-TEMPERATURE CARBONIZATION.

For many years individual investigators have been experimenting on the carbonization of coal at temperatures much below those used in the gas and coke-making industries. While there appears to be some difference of opinion among experts as to the immediate possibilities of low-temperature carbonization, in the existing state of knowledge, it is generally considered that a successful commercial type of low-temperature carbonization plant has not yet been put into operation. Writing in 1918, A. B. Searle, in an Addendum to Professor B. V. Lewes' book on "The Carbonization of Coal," states that, unfortunately, the by-

products of low-temperature carbonization, being chiefly paraffins and olefins, were of less commercial value than those of a high-temperature distillation, which yield oils of an aromatic or benzenoid character. As the yield of gas is low, the coke is of less value for metallurgical purposes, and the existing demands for low-temperature carbonization processes were not great. The writer concluded that if an entirely new demand for the oils produced by such a process were to arise, such as would follow a decision to supply the Naval and Aircraft Services with fuel oils solely produced in Great Britain, or in the event of special legislation relative to the conservation of coal or the abolition of smoke, the prospects of low-temperature carbonization might be entirely changed.

In the last two years, however, with the world-wide scarcity of fuel oils, great progress has been made in the yields of oils obtainable by modern methods of carbonization. Thus in a recent number of *Power* (18th May, 1920), it is asserted that the low-temperature carbonization processes have now been experimented with for years, and that it has now been definitely determined that from 20 to 30 gallons of tar, about 12 lbs. of ammonium sulphate, and about 75 per cent. of coke can be obtained from a ton of bituminous coal. It is also stated that the tar is such that it is possible to obtain from 15 to 20 gallons of motor fuel per ton of coal. These by-products would have a value of from 10s. to 15s. per ton of coal. By gasifying the coke, from 50 to 85 lbs. of ammonium sulphate per ton will be obtained, in addition to 65 to 70 cubic feet of gas. The writer concludes that by combining the two processes—carbonization and gasification—by-products having a value of from £1 to £2 5s. per ton of coal can be obtained.

Though encouraging results have been obtained by certain investigators working out new processes, generally on a laboratory scale, it appears certain that there is still a vast field open for research, and especially for large-scale experiments. With the advent of many highly-trained scientific men into the field, together with the much greater interest many business men are now taking in the researches, there is good reason to believe that progress of the greatest importance will be made in the near future. Since the solution of the problem depends not only on the nature of the coals and the particular processes suitable for their treatment, but also on economic conditions, it is highly important that Australia should participate in the investigations which are being carried out in other countries.

For example, the British Fuel Research Board is now carrying out very extensive investigations into low-temperature distillation, and for that purpose has established a large scale Research Station. In taking this action, the Board was greatly influenced by two leading considerations; the first of these was the possibility of developing an important domestic source of fuel oil for the Navy, while the second was the need for a smokeless solid fuel for industrial and domestic purposes. When considering new and extensive schemes of carbonization, it is necessary to bear in mind that outlets for all the products of carbonization must be found. The gas and coke industries are both of old standing, and each has had to develop outlets for its products by patient and continuous effort. No new carbonization scheme can be justified economically if it can only live by poaching on the preserves of existing industries.

The scheme of work which the Board is carrying out includes :—

1. The further organization and development of a survey of the coals of Great Britain, and in particular as to the suitability of different types of known origin for conversion into gases, fuel oils, and coke.
2. The obtaining of data for the preparation of thermal balance-sheets for various methods of coal carbonization and the gasification of coke, and in connexion with the use of gaseous fuels in industrial furnaces.
3. The obtaining of data for the preparation of economic balance-sheets for carbonization, gasification, and furnacing operations.
4. The obtaining of similar thermal and economic data in connexion with the use of peat as fuel.
5. Experimental work on carbonization at temperatures up to 650° C. and on various types of apparatus for this purpose.
6. The study of the coke produced under (5) from various types of coal as a smokeless fuel for domestic and industrial purposes, either directly or in the form of briquettes.
7. The study of oils produced under (5) as a source of fuel oils for use by the Navy in steam boilers or in Diesel engines.
8. The study of the hydrocarbon gases produced under (5) with a view to their utilization directly as a high grade fuel or as a source of fuel alcohol.

4. POWDERED COAL.

The possibility of applying combustion to powdered coal for industrial purposes, especially in connexion with the utilization of small coal, is also a matter of prime importance in connexion with the subject of coal economy. By pulverizing coal and carrying it forward in a stream of air to a combustion furnace it is possible to obtain perfect combustion with complete prevention of smoke. The first application of this method of burning coal was in the cement industry in the United States of America, where, about 30 years ago, the firing of rotary cement kilns was adapted to the use of powdered coal, the air-coal mixture being injected into the kilns to yield a flame of great intensity and length. In this way more expensive fuels, such as oil and natural gas, were superseded. The application of powdered coal to other industrial operations is extending, especially in the United States of America, where, at the present time, it has reached an annual consumption of nearly 10,000,000 tons of fuel.

Special attention is directed to this matter in the Report of the British Fuel Research Board. It appears that in Great Britain also this development has mainly taken place in connexion with the cement industry, the only other experience of the method in that country being its use by the Admiralty on a limited scale for steam raising in certain forms of land boiler. The British Board was so impressed with the importance of the developments in the United States of America that it sent a special investigator to that country to inquire into the whole position. The information collected has been published by the Fuel Research Board in the form of a Special Report entitled "Pulverized Coal Systems in America." The Board is of the opinion that the matter is of such importance that it has ordered a complete large-scale testing plant for the purpose of investigating the suitability of various types of British coal for use in the pulverized form.

The bare fact that this method is now being applied to the burning of over 10,000,000 tons of coal per annum in America is in itself a strong reason for its serious consideration in other countries. The advantages of the method as an almost perfect means of burning coal must of course be weighed

against the cost of producing and handling coal dust and the difficulties which may have to be overcome in dealing with its ash.

The following are the main conclusions reached in his report by Mr. L. C. Harvey, the investigator appointed by the British Fuel Board :—

1. The advantages of burning coal in pulverized form have been definitely proved in actual practice.
2. The heat values of coals can be utilized to a far higher degree by this means of firing than by any other process.
3. In certain circumstances initial costs for pulverized coal plants are considerably less than the costs for installing producer gas plants.
4. Economy in fuel consumption of from 20 to 50 per cent. can in many cases be effected by the use of coal in pulverized form.

   Of the 513,500,000 tons of coal used in America in 1914 for all purposes, of which, say, 205,400,000 tons were used in the metallurgical and steel industries and for railway locomotives, some 41,000,000 tons would have been saved if pulverized coal had been used exclusively for these purposes.
5. Almost any grade or quality of fuel—anthracite, bituminous, lignite, or peat—can be used efficiently in certain circumstances in pulverized form.
6. Large quantities of what is considered waste coal can be used to good purpose.
7. In suitably designed plants there is practically no danger whatever of the possible explosion of coal dust.
8. A very important start has been made in connexion with the firing of large power-house boiler plants with pulverized coal, and its extension in this direction is likely to develop rapidly.
9. In view of the attention now being given to marine boiler firing by this means, useful and important results are to be expected.
10. Owing to the very considerably reduced amount of labour incidental to a pulverized coal plant, as compared with hand firing and, in certain cases, stoker firing, the labour saving is a most important feature introduced by this system of burning coal.

    Saving in labour is particularly marked in connexion with the firing of railway locomotives by this means.
11. In view of the smokeless combustion of pulverized coal in metallurgical furnaces, and especially in the steel industries, for boiler firing and for locomotives, the abatement of smoke nuisances in large cities by this means can be accomplished to an appreciable extent.

5. DOMESTIC HEATING.

The British Fuel Research Board has carried out, on behalf of the Manchester Air Pollution Board, valuable investigations into the efficiency of open fires used for domestic heating. The results are to be published by the Board as a special report. From the outline of them, given in the Board's General Report, it appears that they are likely to prove of very great interest to the general public. In addition to the direct determination of the heat emitted by an open fire, measurements were made of the volume and temperature of the gases passing up the chimney, so that the heat loss due to this cause was ascertained. This loss was found to vary with the amount of outside air drawn into the room. With an amount sufficient to change the air in the room once every hour, the loss was only 16 per cent., while with ten times this amount of air the loss rose to 50 per cent.

Another important result established by the Board is the superior radiating quality of coke fires, in particular when the coke used has been made by carbonization at a temperature much lower than that used in coke ovens or gas retorts. If in addition to its quality of smokelessness, this form of fuel can be credited with a much higher thermal efficiency than coal when it is burned in open fires under suitable conditions, it is evident that the replacement of raw coal by this material would give a new lease of life to the much

abused but still most popular open fire. The investigations have shown that the familiar characterization of the open fire as "a contrivance in which 92 to 95 per cent. of the potential value of the coal goes up the chimney and pollutes the atmosphere and only 5 to 8 per cent. is utilized in the room" is quite unsupported by the facts. On the other hand, it appears that the "well" type of fireplace is open to criticism, since a great part of the radiant heat goes direct to the ceiling and upper walls. The Report states that if a smokeless form of fuel were available in large residential centres, the problem of permanently raising the efficiency of the open fire would be enormously simplified by the abolition of raw coal as a fuel. "The pleasant British practice of sitting round the open fire," says the Report, "is amply justified from the scientific point of view when we know that so much as one-fifth of the total heat of the coal is immediately available for absorption by the sitters. . . . . ." In addition to the directly measured radiant heat, the open fire is to be credited with heat conducted, radiated, and connected from the fireplace, chimney, and walls to an extent which is such that altogether some 60 to 70 per cent. of the heat of the coal is utilized in warming the room and the general fabric of the building.

6. IMMEDIATE POSSIBILITIES IN COAL ECONOMY.

In the Report of the British Fuel Research Board it is pointed out that the outstanding feature of the present situation is that whilst on the one hand there already exist many experts with a widespread knowledge of means whereby the extravagant methods of consuming coal which are widely prevalent might be so improved as to reduce the consumption for industrial purposes by a very substantial amount, there is, on the other hand, still so much inertia on the part of the consumers that even the simplest and most obvious steps towards improvement are not taken. It is probable that this inertia will be overcome by the increase in the cost of coal. Those who have been in a position to study the matter during the last 40 or 50 years have noted that during times of high prices there is a periodical revival of interest by consumers in the development of more economic methods for coal consumption. Conversely, during the recurring periods of cheapness there has inevitably been a general falling off of interest in economy.

With the present and probable future high price of coal the consumer will be driven in the direction of increased economy, if he is to keep his place in industry. It is necessary, therefore, that the leaders of industries, whose future will be seriously affected by the increased cost of coal, should lay down a programme for its most efficient use, and that such programme should deal first with the prevention of the more reckless waste which invariably tends to develop unless there is continuous skilled control. While it is true that great economy may yet be effected in the consumption of coal by the development of such processes as low-temperature carbonization, the probability of such developments does not relieve fuel consumers of their immediate duty of taking advantage of existing appliances and known methods of reducing their coal consumption. There is no doubt that in the majority of industrial undertakings a reduction of from 5 to 20 per cent. could be secured within a year at a relatively trifling expenditure of wages and small alterations of apparatus. The British Fuel Research Board mentions in its Report that in one case a saving of 30 per cent. of the fuel consumption was effected during one year merely by the application of more perfect control.

Beneficial *versus* Injurious Insects.

By EWEN MACKINNON, B.A., B.Sc.

(II.)

There are three good examples of American work on an extensive scale on the control of injurious insects by the use of beneficial ones. They are (1) Californian work with the ladybird *Hippodamia convergens*, (2) work in the New England States on the Gipsy and Brown-tail Moths, and (3) work in the south-east with the Cotton Boll Weevil.

The first is an example of the third phase previously mentioned, *i.e.*, the use of a native species, increasing by artificial means the number of individuals already present. Each year the State Insectary of California distributes several tons of *Hippodamia convergens* Guer., a native ladybird, to growers of apples, pears, prunes, cantaloupes, vegetables, seeds, and garden crops, for the destruction of many species of aphids.

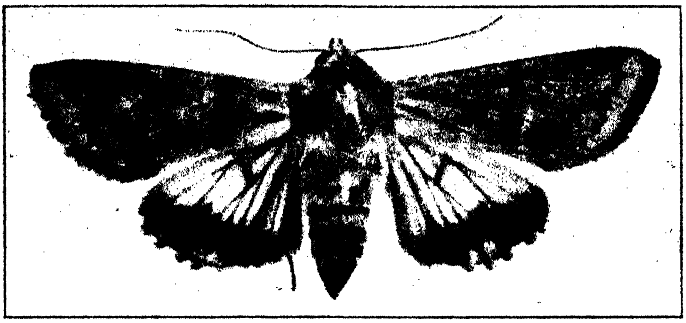
Previous to the adoption of this method of control the melon aphid (*Aphis gossypii* Glov.) had practically prevented the growing of cantaloupes in California, as whole fields were ruined in three or four days. No mechanical or other means had been found effective, and it was only possible to get rid of the aphids by destroying the infected vines. The best results are obtained by placing colonies of ladybirds in the fields or orchards at or just before the first appearance of the aphids, the object being to prevent their increase. The female ladybird, if the natural food is scarce, is thus forced to search for the aphids, and will distribute her eggs in proportion to the number of aphids present. If the colonies were not placed until after the aphids had become abundant, she would deposit practically all her eggs at the same place. Orchards and fields have thus been kept clear of the aphid, and so great has been the demand for ladybirds that the State Insectary has been forced to organize upon a considerable scale and collect the *Hippodamia* in ever increasing quantities.

Such numbers are not propagated at the Insectary. The numbers concerned are enormous, and the food required would be impossible to provide. A consideration of some of the figures will show this. A single consignment or a colony generally consist of 30,000 insects for an area of 10 acres, and is delivered by express trains and coaches, all charges paid, and with a free return for empty crates. Approximately 1,500 adult ladybirds weigh an ounce. Now 1,000 colonies containing approximately 30,000,000 individuals have been prepared for delivery at a time, and in the season 1918-19 as many as 75,000,000 were sent out, chiefly to grain and cantaloupe growers. The thousand colonies weigh about ½ ton, and the 75,000,000 weigh about 1¼ tons. That this number of ladybirds could be obtained, conserved, and distributed at the most favorable times is due to the scientific study of the question over a period of five or six years. Under the influences of many stimuli (*e.g.*, temperature, moisture, hunger, light, and odour, &c.), *Hippodamia* hibernates in enormous numbers in sunny well drained spots usually in

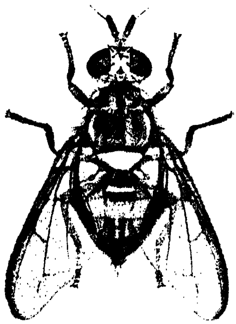
close proximity to water, in the Sierra Mountains. Year after year they return to the same localities and collect under leaves and pine needles on parts of plants, on the ground or on stones, and in the winter often lie buried beneath several feet of snow. The successful location of the hibernation places is one of the achievements of scientists, and two men working together will often collect 50 to 100 lbs. weight of beetles in a day. These are kept in the Insectary in cold storage, and when sufficient are collected they are distributed as required. Storage at temperatures ranging from 31° F. to 43° F. for periods of eight or ten weeks is not very harmful.

When liberated in the field the numbers quickly increase owing to the great fecundity. A single female may lay as many as 70 eggs in a day, and adult emergence varies from 15 to 30 days according to the temperature. The larvæ as well as the fully developed insects are very active predators, and are important factors in controlling the aphids. There is consequently a continual increase of aphid destroyers. The results obtained with this ladybird are a striking testimony to the value of science as applied to agriculture. We have many examples of native ladybirds that are keeping a natural control over various plant lice. They could be made more effective by the application of such methods of propagation and distribution.

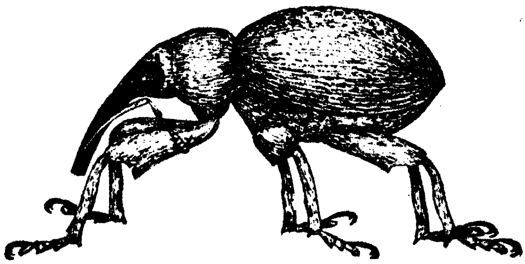
For the second example we go to the New England States, especially Massachusetts, where the work is Forest Entomology. The Gipsy Moth (*Porthetria dispar* Linn.) and the Brown-tail Moth (*Euproctis chrysorrhœa* Linn.) are two European insects whose larvæ are very destructive to a great variety of plants—forest shade and orchard trees. Conifers in each case are immune. The Gipsy Moth reached United States of America about 1869, and is now found in all the New England States. The male is an active flier, but the body of the female is of such a weight that flight is prevented. (See illustration.) Immediately after hatching, the caterpillars can be blown by the wind for varying distances even up to 20 miles. In 1889 it was confined to an area of 1½ miles by ½ a mile, and its extermination was recommended by the leading entomologists. The warnings were disregarded and the money was not provided. Now over a million dollars are spent annually in trying to keep it in check and with no end in sight. The Brown-tail Moth was probably introduced from Holland about 1893. Both sexes are strong fliers, and they are active at night in July. As local parasites had not been in much evidence as a check after many years, it was decided in 1905 to attempt a great effort to overcome the pests. In Europe the Gipsy moth was not such a pest, being kept in control by 27 known Hymenopterous parasites and 25 Dipterous parasites, whereas in United States of America only five Hymenoptera and six Diptera were known as local parasites. Entomologists were sent to Europe (England, France, Italy, Germany, Austria, Hungary, and Russia), and hundreds of thousands of the nests of the Brown-tail and innumerable quantities of the caterpillars and chrysalids of both moths were sent to a forest laboratory near Boston, and the insects were reared in special boxes in insect closed rooms with double doors. The nature of the parasites was carefully determined, and any favorable species were allowed to breed in large outside cages. As soon as



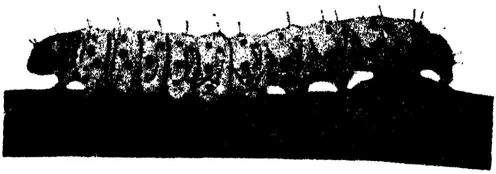
BOLL WORM MOTH.



QUEENSLAND FRUIT FLY
(*Dacus tryoni*).

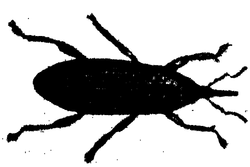


COTTON BOLL WEEVIL (*Anthonomus grandis*).

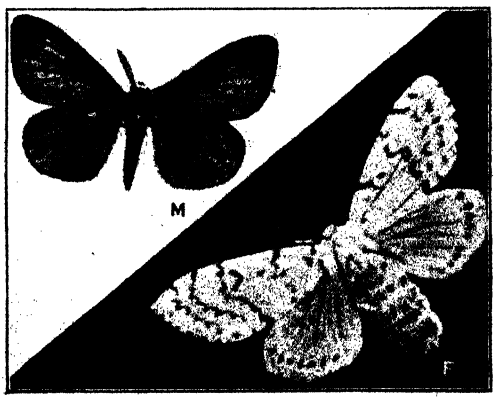


CODLING MOTH LARVA (enlarged about 3 times).

MEDITERRANEAN FRUIT FLY
(*Ceratitis capitata*).



CANE BEETLE BORER
(*Rhabdocnemis obscura*).

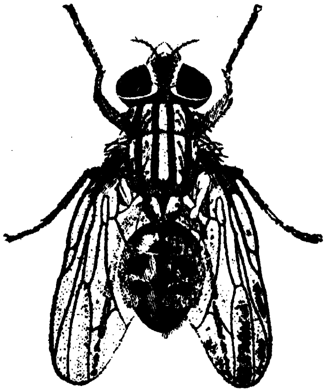


GIPSY MOTH (M, male; F, female).
(*From Slingerland and Crosby.*)

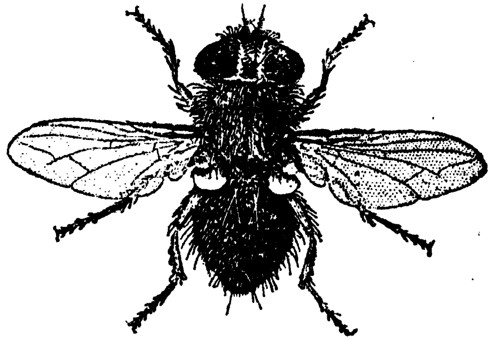
acclimatised they were liberated when and where desired. From 1905 to 1913 more than thirty species of parasites were imported from Europe and Japan. The problem of the control of these two moths has not been an easy one to solve. From a study of this life-history of the Gipsy moth it was ascertained that the probable potential increase is about 250 fold annually. On account of very heavy death rates, the effective rate of increase is only six to ten fold. How, then, could sufficient parasites be secured to keep the development in check? If the increase annually be six fold, then five out of every six insects (over 80 per cent.) in any condition would require to be effectively parasitized, and if ten fold, then nine out of every ten must be similarly destroyed. To effect these results it therefore became necessary to secure a sequence of parasites, attacking every stage of development—the egg, caterpillar, pupa, and moth itself. This required considerable research work, and these investigations have been responsible for some of the most noted advancements in biological control work. The most successful parasites (Lockhead, Ec. Ent.) now include the following:—

Gipsy Moth.—Egg parasites	..	2 imported Ichneumons.
Larva parasites	..	2 imported Tachinids.
		1 imported Predatory Beetle.
Pupa parasites	..	1 imported Chalcid.
Brown-tail Moth.—Egg parasites	..	1 Native Chalcid.
Larva parasites	..	1 imported Chalcid.
		2 imported Braconids.
		3 imported Tachinids.
		1 imported Beetle.
Pupa parasites	..	1 native Chalcid.
		1 imported Chalcid.
		1 native Ichneumon.

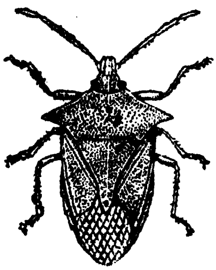
3. At the time when the Gipsy Moth parasites were being imported the parasites of the Cotton Boll Worm were also under extensive propagations. The Cotton Boll Worm is the larva of a moth *Heliothis obsoleta* Fab. belonging to the family *Noctuidæ*, *i.e.*, night fliers. Until the advent of the Mexican cotton boll weevil (*Anthonomus grandis* Boh.) the Boll Worm was by far the most serious of the numerous insect pests of the cotton plant. The coming of the weevil has not lessened the destructiveness of the Boll Worm, but its injuries have been overshadowed by the more serious depredations of the weevil. This weevil first attracted attention in Texas in 1894, and it has the record of developing in less than twenty years from a most obscure species to one of the most important economically in the world. The moth *Heliothis* was known about 100 years before the weevil, and is practically cosmopolitan. Its original home was most likely America. In Australia it is better known as the Maize Moth, and in other countries it is called the Tomato Moth, and in many parts of the United States of America, in the larval stage, as the Corn Ear Worm. In 1900 it caused a loss of sweet corn of approximately £400,000, and an annual loss of over £3,000,000, or on corn, cotton, and tomatoes of over £5,000,000 annually. In 1903 the weevil caused a loss of £3,000,000; in 1904, of £4,500,000; and in 1909, of £18,000,000. From 1895 to 1914 the loss caused by the weevil has been estimated (by the United States of America Bureau of Entomology) at £140,000,000. We already have the Boll Worm Moth; can we prevent the entrance of the weevil (*Anthonomus*)? In many



GOLDEN-FACED FLY
(*Sarcophaga aurifrons*).

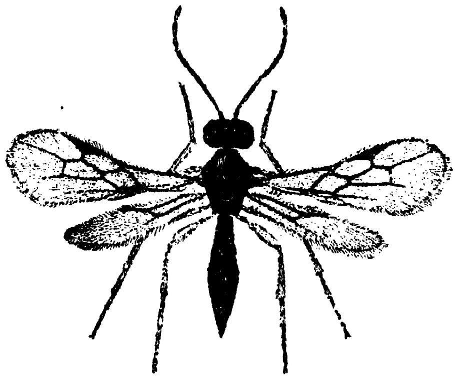


PLAGUE GRASSHOPPER PARASITE
(*Masicera pachytili* Skuse); enlarged.

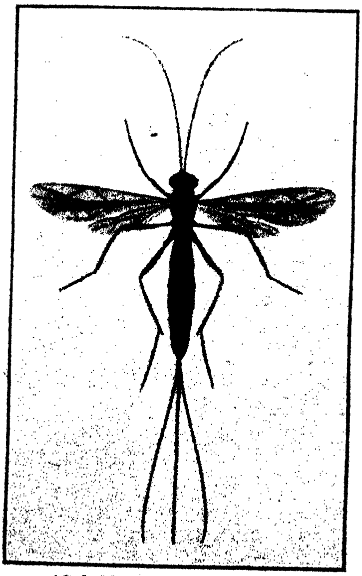


[*Friendly Insects.—Froggatt*, p. 18.
Farms. Bul., 34.]

VINE MOTH BUG
(*Oechalia schellembergi*).

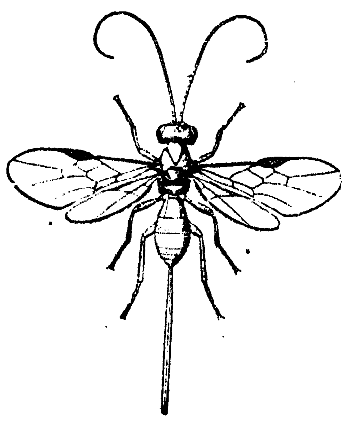


PARASITIC BRACONID WASP
(*Ephedrus persicæ*).
Parasitises Wingless Peach Aphid.



[*Cal. M. Bul., Vol. III., No.* 5, *p.* 197.

***Calliephialtes*, Sp.** ♀.
A Parasite on Codling Moth Larvæ.



DIACHASMA TRYONI ♀ (*after Silvestri*).

parts of Texas, cotton-growing has been replaced by peanut-growing, and the mills left vacant on account of the want of seed for crushing, because of the havoc wrought by the weevil, are once more producing oil, and an annual value of £13,000,000 has been added to the production of Texas. The once-despised peanut yields 50 per cent. of oil.

At the present time there are about fifty-four insects known to attack the boll weevil. The predatory ones simply cut into the cotton squares and devour the young stages of the weevil, and, in some cases, the adult. Ants (*e.g.*, *Solenopsis geminata*) are most numerous in this class. Ground beetles, in both the adult and larval stages, are also effective. The American species are numerous, and the parasites include many Hymenoptera, especially the Chalcid order, *e.g.*, species of *Catolaccus, Eurytoma,* and *Microdontomerus*. There are also Tachinids and many Braconids. The methods of collecting, propagating, and distributing to places where the species are either absent or small in numbers, and the elimination of related weevils by the destruction of their food plants in or about the cotton fields, thereby forcing the parasites to transfer their attention to the boll weevil, have been adopted with good results. Under the plan of elimination of related weevils the case of *Anthonomus albopilosus* may be cited. This weevil confines its attack to a species of Croton, a weed that is readily controlled, and the beetle is parasitized by three different insects which will also attack the boll weevil. By mowing the weed at the proper time the Croton weevil largely perishes for want of food, and its parasites are forced to turn to the cotton boll weevil or else perish.

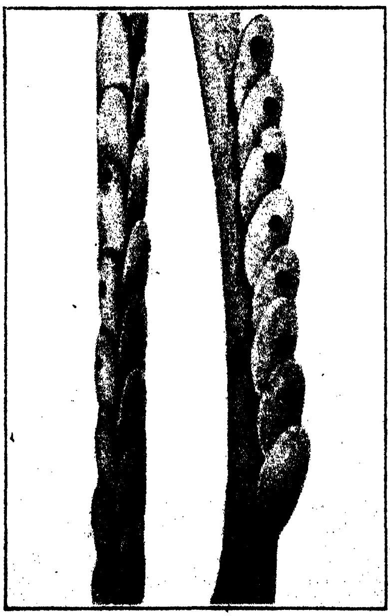
Australia, with her rich insect fauna, has already provided many beneficial insects for other countries. There are numerous directions in which these same friendly insects can be utilized with advantage in our own land. The biological methods of control might be greatly extended to bring under subjection, not only the pests of the agriculturists, but also insects concerned in the spread of diseases. It is the American's boast (Ball; J. Ec. Ent. 12: 24) that yellow fever no longer exists under the Stars and Stripes; that the bubonic plague—the triple alliance of the rat, the flea, and the bacillus—has been routed out; that scabies, the scourge of the western range, has practically disappeared as a menace to the sheep industry. He further claims that the Cottony Cushion Scale has been subjugated, and Gipsy and Brown-tail Moths compelled to entrench. The Pink Boll Worm is now in retreat, and the Texas tick has been pushed southward towards the Gulf, and will eventually disappear. The spirit of conquest is in the air. Such achievements have been notable, and, no doubt, will be followed by others equally as great. A plan of storing cotton in advance, and refraining from growing for a season, has been proposed for cleaning up entire regions in a single year. Dr. Pierce has produced a manual of dangerous insects occurring in foreign countries and which have not yet reached the United States of America. The list includes 2,500 different kinds of insect pests, any one of which might, if introduced, cause untold losses. California spends £1,000,000 annually in controlling about a dozen insects in less than 1,000,000 acres of orchard.

When we consider that the majority of our injurious insects are foreign invaders, or, as we say, are exotic, and that many more of the


LARVA OF COTTON BOLL WEEVIL ATTACKING COTTON BOLL (U.S.A. Bur. Ent.).


LARVA OF COTTON BOLL WEEVIL WITHIN COTTON BOLL (U.S.A. Bur. Ent.).


EMERGENCE HOLES OF TACHINID FLIES FROM PARASITIZED PUPÆ (U.S. D.p. Agr.).


GRASSHOPPER EGGS, SHOWING EXIT HOLES OF AN EGG PARASITE (*A. chalcid*). *Eupelmus mirabilis.*

most serious pests have not yet found footing in Australia, we have cogent reasons for devoting so much attention to entomological work undertaken in other countries. I do not know of any general analysis of our injurious insects. In the United States of America considerably more than half are exotic. In New Zealand (N.Z. Jour. Sc. & Tech., July, 1919) Miller has classified the insect pests according to country of origin as follows:—New Zealand, 20 per cent.; European, 66 per cent.; Australian, 9 per cent.; North American, 2 per cent.; South African, 1 per cent.; Pacific, 1 per cent.; and according to habitat as follows:—Noxious on live stock and man, 22 per cent.; orchard pests, 27 per cent.; stored products and household goods, 20 per cent.; field and vegetable crops, 20 per cent.; and 10 per cent. undistributed. An analysis of Australian noxious insects would, no doubt, be somewhat similar to this. These preliminary surveys, with the losses caused by such pests, are of great value, as they provide the only means by which we can view in proper perspective the relative importance of the many projects requiring investigation, to prevent undue prominence and attention being given to minor problems which, presented individually, may appear to be of great importance from a local point of view, or for a single State, but which, in the federal scheme, may be reduced to positions of less significance.

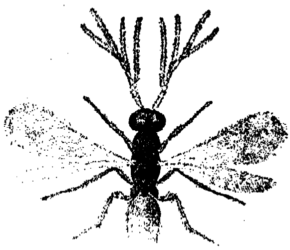
In the past, some of the problems selected for investigation have been those which were apparently of great economic importance, *e.g.*, control of the Cattle Tick and the Sheep Blowfly, the search for the vector of the nodule-producing worm in cattle. These along with other problems, whether entomological only or general biological questions, should now be examined comparatively and their relative importance estimated, so that a well-balanced scheme of investigation can be prepared.

In such a programme, investigation at present in progress on the propagation of a few parasites of the Sheep Blowfly in Queensland and New South Wales will probably be greatly extended, and the question of importing other parasites will receive due consideration. What has already been done in Australia will have to be thoroughly summarized, and the causes for such poor results being obtained with methods that have proved successful with all manner of pests in many other countries will have to receive the most searching examination by well-trained biologists.

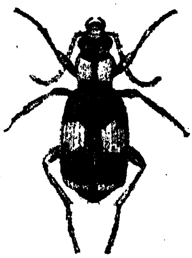
The work that Australia has probably taken most interest in was that in reference to fruit flies. The most universally distributed fruit fly is the so-called Mediterranean Fruit Fly (*Ceratitis capitata* Wied.), while another in New South Wales and Queensland is *Dacus Tryoni*. These belong to the family Trypaneidæ of the order Diptera. *Ceratitis capitata* was first recorded in Australia in 1897, almost simultaneously in New South Wales and Western Australia. It was the Western Australian Government that first took alarm at the destruction caused by *C. capitata*, and sent their entomologist, Mr. George Compere, on several trips abroad in search of natural parasites, for introduction into Australia. The first trip was through the Philippines, China, Japan, California, and Europe. He did not find any parasites of the Mediterranean Fruit Fly, but found some of Codling Moth. He made other trips from 1904 to 1907 to Ceylon, and India, and Brazil. From

Brazil he wrote of his success in finding Braconid parasites and a predatory Staphylinid beetle that would control the fruit fly, but even after his second trip there, in 1905, the material collected did not give much promise of success. It was in India that he had most success. There he searched for parasites of the genus *Dacus* (or *Bactrocera*). On his first return to Perth it was winter, and no hosts were available for his parasites, which died. He returned to India in 1907, and collected approximately 100,000 parasitized pupæ and successfully transported them to Australia. In India he preserved his specimens in soil in small tins, packed in ice, which had to be renewed each day. The most important parasite that he secured was a Chalcid *Syntomosphyrum indicum*, of which as many as thirty-six individuals were seen to emerge from a single pupa and the average was twenty. Of two other parasites only one of each emerged. At the same time six specimens of the adult fruit fly of India hatched out, but were said to have been promptly destroyed. The Government afterwards shipped some 20,000 to South Africa (1908), and some to Dr. Silvestri, in 1909. From this material Dr. Silvestri hatched out in Italy the same Chalcid, and also two male Braconids. The *Syntomosphyrum* were liberated in thousands in Calabria, but failed to establish themselves. In 1906-7 W. W. Froggatt also went on a tour of the world in connexion with fruit flies, but parasites were not brought back. Both of the above entomologists omitted West Africa, which, according to Dr. Silvestri, is probably the original home of *Ceratitis capitata*, and he was employed by the Board of Agriculture at Hawaii to visit Africa and other places to obtain fruit fly parasites. Dr. Silvestri thus introduced into Hawaii different species of parasites of the genera *Opius*, *Galesus*, and *Dirhinus* from other species of *Ceratitis*, but all of which attacked *C. capitata* freely. From Australia he secured *Diachasma Tryoni*. Two species of the introduced African parasites produced males only, so that finally four active parasites were available. Such success has been gained that the number of larvæ of *C. capitata* parasitized averaged 33 per cent. in 1916, 47 per cent. in 1917, and 56 per cent. in 1918. This has been of great benefit to Hawaii, and has decreased the danger of the introduction of the fly to California. What can be done in Hawaii could, no doubt, be repeated in Australia, notwithstanding the divided opinions of some of our entomologists.

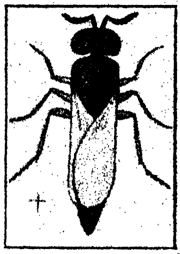
In Queensland also we find good progress being made with the control of the many sugar-cane pests. The Beetle Borer (*Rhabdocnemis obscurus* Boisd.) is a serious pest in Fiji and parts of Queensland. Mr. Tryon discovered a Tachinid parasite (*Ceromasia sphenophori* Vil) in New Guinea, and this was introduced into Fiji for the Colonial Sugar Company by Frederick Muir in 1911. There it quickly spread, and is now successfully combating the borer. Consequently, in 1914 it was also introduced into Queensland, and after several years it is now "making good" in the Mossman district, where 90 per cent. of the grubs of the borer were recently found to be destroyed. It was also successfully introduced into Hawaii, and in 1917 about ninety puparia were sent to Louisiana, and twenty-three flies were bred out. It has been found that some success is being gained in controlling the Moth Stalk Borer (*Diatræa saccharilis* Fab.), which also exists in Queensland, where it is already under natural control by native parasites.



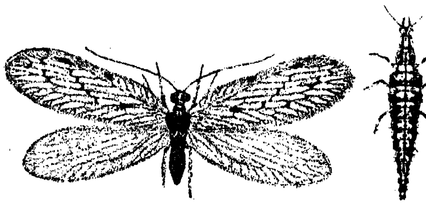
A CHALCID WASP
(*Ceraphron niger*).
Parasite on Leaf Mining Fly.



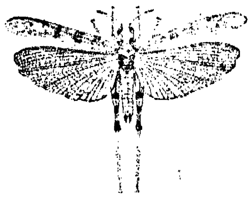
CARNIVOROUS BEETLE
The "Yellow Bombardier Beetle"
(*Pheropsophus verticalis*).



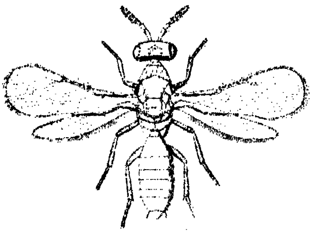
Scelio australis.
Egg Parasite of Northern Plague Locust (*Locusta australis*).



1. **2.**
LIFE HISTORY OF THE BROWN LACE-WING
(*Micromus australis*).
1. The perfect insect. 2. The active larva.

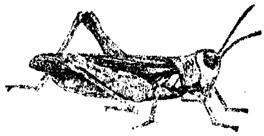


THE WANDERING PLAGUE LOCUST ♀
(*Chortoicetes terminifera*).

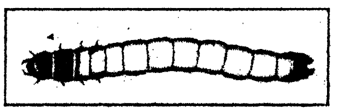


Syntomosphyrum indicum. ♀

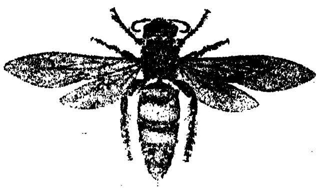
***Dielis formosa* larva**



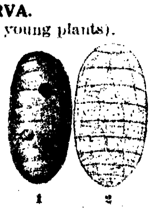
THE SMALLER PLAIN LOCUST
(*Chortoicetes pusilla*).



ELATERID LARVA.
Wire Worm (destructive to young plants).

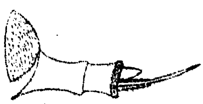


SCOLIA WASP
(*Dielis formosa*).



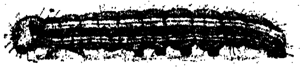
1 2
Puparium of *Ceratitis*
(*after Silvestri*),
with three holes, from one of which an adult of *Syntomosphyrum* is emerging. Another puparium containing larva (*Syntomosphyrum indicum*).

Larva of *Dielis formosa* attached to White Grub of Sugarcane Beetle.



Lateral View of the last Abdominal segment and extended ovipositor of *Lestophonus*.

***Dirhinus giffardii* ♀ ovipositing in a puparium of *Ceratitis*.**



CUTWORM.

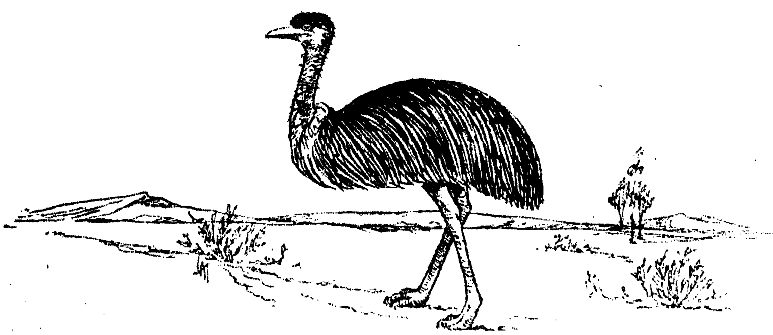
There are many Lamellicorn beetles whose larvæ attack the roots of sugar cane in Queensland and New South Wales. A parasitic wasp (*Dielis formosa* Guer.), of the family Scoliidæ, and known as a Digger wasp, burrows down through the soil, and the female stings the grub and deposits a single egg on its under surface. When the egg hatches, the larva buries its head within the beetle grub and lives on its contents.

A similar wasp, *S. manilæ*, has been introduced from the Philippines into Hawaii, and is successfully controlling the white grubs of *Anomola orientalis*.

A common pest in our gardens is the cabbage aphid, and in New South Wales the introduced parasite *Lepolexis rapæ* Curtis can be readily collected. Many similar examples could be given, but sufficient has already been shown that Australia, with abundance of material, has not made use of her opportunities.

In science, as in art, and, as I believe, in every other sphere of human activity, there may be wisdom in a multitude of counsellors, but it is only in one or two of them.

—*HUXLEY.*



The Utilization of Leather Waste.*

BY A. HARVEY.

The profitable utilization of scrap leather is a problem which has often occupied the minds of tanners, and has been the subject of a large number of patent specifications in this country and abroad. In the majority of cases such specifications deal with the manufacture of leather substitutes or "recovered" leather from such scrap, but it must be remembered that there are other outlets which can be, and are, sometimes considered, viz.:—

1. Detanning and preparation of glue.
2. Manufacture of leather boards.
3. Manufacture of fertilizers.

Detanning and Glue-making.

One of the best known of the earlier patents on this subject is by Trotman, in which the finely divided leather is soaked in dilute acids or lime water, and then treated with sodium peroxide or some other oxidizing agent capable of liberating hydrogen peroxide. In the case of chrome leather, such treatment converts the chromic oxide into alkali chromate, which can be recovered, while the residual skin or hide substance can be treated in the usual manner for glue manufacture.

Stripal in English Patent 3437/1910 detans chrome leather by heating the material, previously cut in small pieces, with a $\frac{1}{5}$ per cent. solution of either hydrochloric or sulphuric acid to a temperature of 50–100° C., whereby it is claimed the leather is detanned almost immediately. An ingenious idea is embodied in an American patent by Holloran. The leather is put into a vat containing a solution of common salt, through which an electric current is passed, after which it is washed in a bath of chlorine water, and again in clean water. This effects detannization, and from the hide is prepared a glue by the ordinary processes. As a by-product, sodium hypochlorite can be made by mixing the electrolyzed solution with chlorine liquor, when precipitation of the tannin matter also takes place. Another process for chrome-tanned waste is by Sadlon. Here the leather is soaked in caustic soda solution until it becomes pulpy. The mass is afterwards neutralized with acid and washed with water, when it can be converted into glue by merely gently warming, and not boiling, as is usually the custom, with water.

The most modern process for dealing with chrome leather is that worked out by Lamb, and is given in English Patent 132,864/1920. In this case use is made of organic acids containing two or more hydroxyl groups, such as lactic, tartaric, malonic, and oxalic acid. The leather waste is soaked in this acid solution until detannization is complete. From the liquor is recovered the chromium and the detanned material used for the making of glue. The present writer has seen some good glue stock made by this method.

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* Extract from *The Leather World*.

Chrome alum can also be made from the recovered chromium from chrome leather, and mention is made of this in Wolff's German patent. The chrome leather is dissolved in 5 per cent. H_2SO_4 by heating to 80–90° C., and fat separating out being recovered, although in the writer's opinion it would be better to treat de-greased leather, as a better yield of fat would be obtained, and the subsequent processes made cleaner. From the solution the chrome, together with the SO_4, &c., are precipitated by adding an excess of lime. This precipitate is next re-dissolved in a definite quantity of sulphuric acid and potassium sulphate, and from this solution, after clarifying and concentrating, the chrome alum is allowed to crystallize out.

The glue liquor is freed from any excess of lime by a current of CO_2. The following quantities given will indicate the approximate amounts to use, but it is reasonable to suppose that the final yield of chrome alum will depend upon the chrome content of the leather:—

600 lb. leather cuttings.
2,000 lb. 5 per cent. H_2SO_4.

Precipitated chrome sludge treated with—
40 lb. potassium sulphate.
600 lb. of 5 per cent. H_2SO_4.

Yields of finished products—
About 150 lb. glue,
About 180 lb. chrome alum,

or, in other words, 50 per cent. and 60 per cent. respectively on the weight of leather used.

The novel use of enzymes in the preparation of hide glue from waste is mentioned in Rohms' German Patent No. 303,184. The waste leather is first treated with a dilute solution of caustic soda, and the residue subjected to a further treatment with the enzymes of the pancreatic juice. In order to prevent any actual decomposition of the hide during this digestion, addition is made of such materials as ammonium salts, amino acids, or some other type of protein degradation products which act in the manner of an inhibiting agent.

Manufacture of Leather Boards.

Having mentioned a few of the patents concerning the preparation of glue, attention will now be turned to those connected with leather substitutes and boards. Needless to say, the composition of these substitutes varies very much, and almost anything can be used in conjunction with the leather to act as a filling or binding agent. One of the usual constituents is rubber, either new or scrap stuff, in which cases the mixture is usually submitted to a vulcanizing process. Thus W. S. Smith in his specification uses 60 parts of reclaimed rubber, 30 parts of leather waste, and 10 parts of ground-up outer covers of tyres. Sulphur is subsequently added together if necessary with some blown oil and any fibrous material available. The whole is finally vulcanized. The product can be used as a sole leather substitute, for floor coverings, pump discs, and crutch shoes.

Quite recently a new process of vulcanizing has been invented by Mr. Peachey, of the College of Technology, Manchester, which consists in first exposing the material to be treated to the action of sulphur dioxide gas, followed by a treatment with sulphuretted hydrogen. The result is that sulphur in a very active form is produced throughout the material, vulcanization being immediate without the action of heat. Such a process as this would be very useful for the thorough vulcanizing of such mixtures as are used in the manufacture of leather compositions and substitutes.

In several instances the success of many patented processes depends upon the fine grinding or pulverizing of the leather, and for this purpose a special machine was introduced by A. W. Case (U.S. Patent 690,097 of 1901). Another artificial leather compound is prepared by heating, &c., a mixture of the following percentage composition:—Chinese wood oil (Tung oil), 5 per cent.; acetone, 50 per cent.; nitrocellulose, 20 per cent.; pigment, 15 per cent.; leather, 10 per cent. Here, no doubt, a large part of the acetone is recovered in a specially-constructed apparatus. A very elaborate method for making what is called "reconstructed" leather is described by Exbrayat and Loup in French Patent 397,972 of 1908. The leather is first softened by steam and the tannin removed by ammonia, and afterwards soda. The detanned, or partly detanned, stock is next washed with water and beaten in a machine to make it fibrous, after which it is treated with a bleaching powder solution and washed. To the purified pressed mass is added a certain quantity of an albumin solution, and again pressed with a hydraulic press. The thin sheets are next tanned by any known process, pressed, glazed, waterproofed, and finished. It will be seen that the albumin added is precipitated or tanned by the tanning material subsequently used, and this somewhat sticky precipitate acts as a very good binding agent for the rest of the leather fibre.

It is noticeable, too, in many patents that use is made of the binding properties of some of the metallic soaps. For instance, leather waste properly treated is given a bath of soap, the fatty acids of which are after precipitated within the fibre, as an insoluble soap, by adding alum. The stuffing of artificial or substitute leather is dealt with in French Patent 386,420 of 1908, by Case, who suggests a mixture of resin and mineral oil or wax.

Fertilizers from Scrap Leather.

As is probably well known, leather contains a certain amount of nitrogen, which, although a valuable fertilizer, is very slowly indeed available when used on the soil. This means to say that the rate of decomposition is very slow. Here it might be mentioned that only vegetable-tanned leather is referred to, as it has been definitely shown that chrome leather acts as a poison to plant life.

The majority of patent processes have for their object the solublizing of the nitrogenous matter. the simplest being an acid treatment. This is mentioned by Fuchs in U.S. Patent 841,501 of 1906, who removes the soluble tannin by washing with water, and then subjects the residue to the action of H_2SO_4. The resultant material is

afterwards dried and powdered. A more drastic method is described by Feldmann in a French specification, and is applicable to old boots and the like. These are treated with steam under pressure until reduced to a paste. This is mixed with lime and dried to a powder, containing 9 per cent. of nitrogen.

Very often the leather is mixed with other manurial substance to form what is termed a "mixed" manure. One idea on these lines has been patented by Leblanc. The leather is dissolved in H_2SO_4 of a gravity of 1.563 by heating under pressure. This pasty mass is mixed with mineral phosphate and dried. Such a method as this has two objects: the leather is rendered soluble, and, in addition, the mineral phosphate is also made more suitable for use as a manure. Finally, by a process of destructive distillation it has been shown by Lamb that almost a theoretical yield of ammonia can be obtained, and the residual "char," or carbon, purified and used for decolorising purposes. In a paper published in the J.S.C.I. for 1917 on the utilization of condemned army boots, it was shown that, as the result of a number of tests, 35 per cent. of crude charcoal is obtained, which on purification with acid and alkali gives 25 per cent. (on the original leather) of pure charcoal. This product compared well with bone char as regards decolorizing power.

Before concluding, mention should have been made of the property possessed by Rochelle salt of dechroming chrome-tanned leather, first pointed out by Procter and Wilson. In a paper published on the subject it was proved that this salt would completely dechrome, and from the residue could be made a satisfactory glue. At the same time the chrome could also be recovered from the solution. Rochelle salt is a dear chemical, but, as pointed out by the authors, can be completely recovered and used again.

The British Department of Scientific and Industrial Research has approved of the formation of a Research Association for the silk industry. The Secretary of the Association is Mr. A. B. Ball, The Silk Association of Great Britain and Ireland, Kingsway House, Kingsway, London, W.C. 2.

Construction work for the Tokyo Scientific Laboratory, started some time ago under the auspices of the Science Association at an estimated cost of £300,000, is making speedy progress, and the latest news is that already the Physical Department has been completed. With the completion of this construction, the country will have one of the most perfect scientific laboratories in the Orient.

Scientific and Technical Societies.

LINNEAN SOCIETY OF NEW SOUTH WALES.

At the August meeting, Mr. Norman Bartlett Friend, 42 Pile-street, Dulwich Hill, was elected an ordinary member of the Society.

A circular was received from the Australasian Association for the Advancement of Science (Mr. J. H. Maiden, Permanent Honorary Secretary), announcing that the next meeting is to take place in Hobart on 5th January, 1921.

PAPERS READ.

1. A list of the species of Australian *Carabidæ* which range beyond Australia and its dependent islands. By T. G. Sloane.

Forty-four Australian species are recorded from localities outside Australia and its dependent islands as follows:—Africa, 1; Amboyna, 1; Aru Islands, 1; Asia, 6; S.E. Asia, 4; Borneo, 1; Burma, 1; Celebes, 3; Ceylon, 5; Egypt, 1; India, 2; Java, 8; Lord Howe Island, 2; Malay Archipelago, 6; New Caledonia, 12; New Guinea, 10; New Zealand, 3; Siam, 1; Sumatra, 1; Sumbawa, 3.

2. On dental incrustations and the so-called "gold-plating" of sheep's teeth. By Thos. Steel, F.L.S.

For many years past there have appeared from time to time in newspapers and magazines published all over the world statements as to the occurrence of a metallic incrustation on the teeth of sheep. Popularly this incrustation, being frequently of a yellow tint, has been attributed to gold, supposed to have been derived from particles of that metal scattered about the pastures. Complete analyses are given of the incrustation from sheep, ox, man, and a number of other animals, and it is shown to consist of a phosphatic salivary deposit or calculus, and that it is common to the teeth of all mammals and of several other animals.

3. On the structure of the resin-secreting glands in some Australian plants. By Marjorie I. Collins, B.Sc., Linnean Macleay Fellow of the Society in Botany.

An account of certain types of glandular hair and of the development of the glands observed during an investigation of the resinous secretion of the bud in seven Australian genera of the Natural Orders *Sapindaceæ*, *Leguminosæ* (Sub-order *Mimoseæ*), *Compositæ*, *Goodeniaceæ*, and *Myoporineæ*.

4. The Geology and Petrology of the Great Serpentine Belt of New South Wales. Part ix. The Geology, Palæontology, and Petrography of the Currabubula District, with notes on adjacent Regions. By Prof. W. N. Benson, D.Sc., F.G.S., W. S. Dun, and W. R. Browne, B.Sc., Section B. Palæontology.

(i) Descriptive portion (W. S. Dun and W. N. Benson). Over ninety species are recognised, comprising corals, bryozoa, brachiopods, pelecypods, gastropods, scaphopods, cephalopods, and trilobites, of which five forms previously reported have now been for the first time critically examined, seven are new records for the State, and fifteen species and three varieties are described as new. One new genus of corals is also proposed—a simple turbinate form with a corallum of the *Lithostrotion* type. Notes are added by Professor Lawson on two indeterminable plant-petrifactions. (ii) A comparison of the Burindi fauna with the Lower Carboniferous faunal succession in the British Isles (W. N. Benson) shows that on the evidence of thirty-one British species of brachiopods in the Burindi Series it should be placed at the very base of the Viséan Series or on the Tournaisian-Viséan boundary. This accords remarkably well with De Koninck's conclusions put forward forty years ago. The presence of some typically Viséan and typically Tournaisian forms suggests the possibility of faunal zones into which the Burindi Series may ultimately be divided, though it is held that this will not readily be proved. In an appendix, F. Chapman describes one species of *Chætetes* and one genus and three species of Bryozoa as new.

NOTES AND EXHIBITS.

Mr. T. Steel exhibited a portion of the liver of a domestic fowl showing a common pin 1 inch in length embedded in the liver substance. Both ends of the pin projected for several mm., and were enveloped in liver tissue, the head and point being distinctly outlined. The pin must have been swallowed and then worked its way through the tissues until it became fixed in the position found. Mr. Steel mentioned having been shown the crop of a domestic duck which was crammed with common pins picked up by the bird when running about a back verandah where dressmaking was going on.

Mr. W. W. Froggatt exhibited specimens of the larva of the Cup moth (*Apoda xylomeli*) on a Waratah from Sydney.

Miss V. Irwin Smith exhibited a female specimen of the common "bag moth" (*Metura elongata* Saunders), and gave an account of its observed method of progression up a vertical pane of glass. In climbing it clung to a narrow transverse bar of silky threads by its forelegs, while it spun a similar bar about half an inch higher up, and in two hours spun over 80 rungs and climbed a vertical distance of 4 feet. Each rung was composed of seven or nine strands, the rung always being commenced on the right side and finished on the left. The threads are not sticky, but each is glued down securely at both ends by some adhesive substance.

Mr. W. F. Blakely exhibited specimens from the National Herbarium of *Eupatorium glandulosum* H.B. et K. in Nov. Gen. et Sp. (1820) iv., 122, t. 346, and *Crepis setosa* Hall f. in Roem. Arch. i., 2, 1. The first is a native of Mexico, and is a garden escape, which appears to be well established in several places in the Port Jackson district, namely—Neutral Bay (J. White); Parramatta River near Gladesville bridge; Lane Cove River, Killara; head of salt water, Lane Cove River; between Marsfield and Epping (W. F. Blakely).

On the Lane Cove it is firmly established, and vegetates freely amongst the native vegetation, the moist loamy banks corresponding to some extent to the moist plateaus of its native environment, except that in its native country it thrives at an elevation from 5,000 to 8,000 feet, while here it flourishes at sea level, and appears to be sufficiently stable to be considered a naturalized alien. It is depicted in the Botanical Register t. 1732.

Crepis setosa is a native of Europe and Asia Minor, and is now recorded for the first time for Australia. Several plants were found growing in a lane off Florence-street, Hornsby (W. F. Blakely). In New Zealand it is classed as a roadside weed. For a ready reference to the description, see Hooker's *Students' Flora of the British Isles*, p. 228.

Mr. A. A. Hamilton exhibited a seed of *Butia yatay* Becc. (*Cocos yatay* Mart.), grown in the Sydney Botanic Gardens by J. H. Camfield, which had produced twin seedlings. Worsdell (*Prin. of Plant Terato.*, 1, pl. 9) figures twin seedlings in the "Desert Rod" *Eremostachys laciniata*, and attributes the dichotomy (p. 94) to fasciation. Patterson (*Journ. of Heredity*, x., 350) figures an example of polyembryony in the "Mango," *Mangifera indica*, showing a series of seven seedlings arising from a single seed. The occurrence of twin stems in a seedling of *Acacia juniperina* has been noted by Mr. R. H. Cambage (*Journ. Roy. Soc. N.S.W.*, xlix., 93).

Mr. Fletcher exhibited a stunted branch of *Eucalyptus saligna* with a cluster of about thirty-five four-pronged female galls of the Coccid, *Brachyscelis munita* Schrader, together with numerous grouped or single male galls. One horn of one of the female galls, about 13 inches long, carries a small female gall.

ROYAL SOCIETY OF NEW SOUTH WALES.

At the August meeting, Messrs. R. H. Cambage and H. Selkirk read a paper on "Early Drawings of an Aboriginal Ceremonial Ground." The rough drawings were made by Surveyor-General Oxley in his field-book, at Moreton Bay, in 1824, and show the plan of a spot, as Oxley writes, "where the natives meet after a war with adverse tribes, to make peace." This appears to be the first drawing showing the lay out of a Ceremonial Ground of this nature in Australia, and has remained in obscurity for 96 years.

The following members were elected:—

Dr. S. J. Gilbert, Messrs. A. S. Le Souef, C. W. Mann, and J. Sulman.

ROYAL SOCIETY OF WESTERN AUSTRALIA.

At the August meeting, the retiring President, Mr. Geo. L. Sutton, Agricultural Commissioner for the Wheat Belt, delivered the Presidential Address for the year.

During the course of the address it was pointed out that the war had created a tremendous demand for foodstuffs, and had emptied the world's granary. The filling of the world's empty granary was the dominant need of to-day, and this need was the opportunity for Western Australia's developing her agricultural resources, as the result of bringing new lands of recognised agricultural value into cultivation, combined with the profitable reclamation and utilization of areas at present considered unprofitable for agricultural cultivation and increasing the productivity of lands already under cultivation. In order to develop the agricultural resources, business organization was necessary to settle the new lands. The conduct of experiment work and the organization of a liberal and comprehensive scheme of agricultural education was also necessary to develop the unproductive lands and increase the productivity of the agricultural lands already under cultivation. The establishment of an experiment farm on light land and one eastward of the present wheat line was recommended. The increased German agricultural production during the 25 years prior to 1914 was instanced as the direct and tangible value of experiment work and the organization of agricultural education; and, in order to achieve similar results, the elaboration and extension of the present local system of agricultural education, with special strengthening of the specialized phase, was advocated. The University was also urged to support the Chair of Agriculture because of its association with one of the principal industries of the State.

It was finally pointed out that the means suggested for the development of the agricultural resources of the State required scientifically trained men. The great agricultural need of the day was for these men, facilities for training whom were available at the University. It was claimed to be reasonable to assume that the State, which had made such a signal success of its land settlement, would undertake the training of suitable men in order to fully and profitably develop the settled lands.

ROYAL SOCIETY OF TASMANIA.

At the August meeting, a paper, "*Nototherium mitchelli*, its evolutionary trend—the skull and such structures as related to the nasal horn," by H. H. Scott and Clive Lord, was read.

In their third contribution on the Smithton discovery, Messrs. Scott and Lord deal with a mass of data relating to the evolutionary trend of the *Nototheria* and the structure of the skull. They also deal with a reclassification of the genus. In the first section, they recapitulate their remarks as follows:—"In the *Nototheria* we thus find a group of animals that in Tasmania became extinct late in the Pleistocene times, that were generalized, and yet in part specialized. They retained the racial characteristics that can be relegated to five geological periods—that is from the pre-Eocene to the latest Pleistocene. They show similar developments to those of the perissodactyle ungulates, and without leaving a single modern representative to carry on their race in totality, they left many characters scattered through their marsupial allies—the kangaroos, wombats, and native bears—who still grace our woodlands to-day." In dealing with the taxonomic data relating to the skull, the authors state:—"It appears to us that the interests of science will be better served by founding two well-marked groups than by exhaustively contending the claims of various species, and in this connexion we present the following:—

CLASSIFICATION OF THE NOTOTHERIA.

Group 1. *Megacerathine Group.*

Group 2. *Leptocerathine Group.*

Conspectus of *Megacerathine Nototheria.*—Animals of platyrhine cranial morphology, with flat foreheads and parietal platforms. Nasals not quite

covering the nasal aperture, if anything more so in the female than the male. Zygomatic arches asymmetrical, the difference being well marked. Suborbital bar heavy, and slightly grooved at the malar suture. Tooth line showing fairly even wear throughout. Teeth with well marked cingula. Cervicals with strongly developed zygopophyses and powerful . . . . axian spine. Coronoid process of the mandible twisted from the tooth line, as in the latrifrons wombat's jaws. Skull heavy, short nosed, and horned. A second small horn may have rested on the frontal cavity. Nasal cartilage attached by bony studs, capable of motion, to resist shock when horning a foe and also to give extra mobility to the lips. (Example—*Nototherium mitchelli.*)

Conspectus of *Leptocerathine Nototheria.*—Animals of leptorhine cranial morphology, with triangular foreheads and parietal crests. Nasals curved over nasal aperture. Zygomatic arches symmetrical, rounded, and deeply grooved. Tooth line showing uneven wear, the excess always being anterior. Teeth without cingula of a heavy type. Cervicals with a slender axian spine. Coronoid process not much, nor at all, twisted from the tooth line. Skull heavy (less than the other group), long-nosed, and armed with small nasal bosses or very weak horn. Nasal cartilage attached by bony studs, capable of motion, but tending to fuse at maturity owing to longer nose and weaker horn. (Best known example—*Nototherium tasmanicum.*)"

Lecture:—"Mental Efficiency. A study of the results obtained by testing children by the Binet-Simon Scale." By H. T. Parker.

The lecturer dealt with a number of tests carried out by him at country schools in Tasmania.

SOCIETY OF CHEMICAL INDUSTRY, VICTORIA.

A paper on cellulose acetate and raw materials was read before the Society of Chemical Industry of Victoria by J. R. Cochrane. It records details of some research work carried out at the Commonwealth Government Cordite Factory under the direction of Mr. A. E. Leighton, F.I.C., with whose consent the information is published. The object of the work was to supply the Australian Air Force with "dope" should the need arise. Dope is essentially a solution of a cellulose ester—the nitrate or acetate, *e.g.*, in a suitable solvent such as acetone or methyl acetate. The solution is used to produce a waterproof covering for the wings of aeroplanes. Cellulose acetate is generally preferred on account of its relative non-inflammability, and a slightly modified form (hydrated) of the tri-acetate has been prepared. This is a white opaque fibrous material, soluble in acetone, methyl acetate, and ethyl formate, and is plastic in chloroform. Certain ingredients are added to improve the quality of the film by decreasing the rate of drying, and rendering the product more pliable, though tougher.

In England and France the manufacture is in the control of one firm, and the process is kept secret. Good results have already been obtained by the chemists at the Cordite Factory. The raw materials required are (1) cellulose, in some form, (2) acetic anhydride, (3) glacial acetic acid of at least 98.5 per cent. strength, and (4) a so-called catalyst.

1. *Cellulose.*—In Europe and America, tissue paper is generally used. Cotton waste can be used, and it is more readily available in Australia. It must be of good quality, conforming to the War Office specification for that required for the manufacture of explosives. The viscosity of the cellulose esters vary, and much research has been carried out to discover the causes of variation, whether due to differences in the raw product or to manufacturing methods. It has been found that the viscosity decreases with the treatment of the cotton. This is important, as the ester has to conform closely to the specification for viscosity.

2. *Acetic Anhydride* is the most expensive of the raw materials, and most of the cost of the ester is due to that of the anhydride. In general, acetic anhydride is produced by the action of the chlorides or oxychlorides of phosphorus or sulphur on anhydrous sodium acetate. Local conditions determined sulphur monochloride as the product to be used, and a small plant was designed and erected. The body is composed of a jacketed hemisphere of cast iron 20 inches internal diameter. A charge consists of 15 lbs. of powdered anhydrous sodium

acetate and 10 lbs. of sulphur chloride. The anhydride is finally distilled off. The cast iron appears to be quite suitable. The resulting product is a mixture of acetic anhydride and acetic acid, and the maximum yields (90 per cent.) were obtained when the proportions by weight of the acetate to the chloride were as 100 to 67. The crude anhydride contains 75 per cent. acetic anhydride, and is distilled in a copper vessel over copper oxide to fix the sulphur, which is stated to have an injurious effect on cellulose acetate. Commercial acetic anhydride contains 80 to 90 per cent. anhydride, and 10 to 20 per cent. of acetic acid.

3. *Acetic Acid* must be 98.5 per cent. pure, and be free from sulphur and organic sulphur compounds, chlorides, &c. A process of manufacture of cellulose acetate has been worked out which yields a product complying with the British Air Board's specifications of 1918. The catalyst used throughout is sulphuric acid of 90 per cent. strength, which is mixed with the acetylating acid (30 to 40 per cent. of acetic anhydride and the remainder of acetic acid) before being added to the cotton waste. Incorporation is performed in a phosphor bronze jacketed incorporator, and the process takes about 11 hours, during which cold brine is circulated through the jacket. The product is an amber-coloured opaque stiff dough. This is ripened in a copper vessel heated gradually in a water bath. At the end of 13 to 15 hours the material resembles in its viscosity and appearance a light-coloured treacle. A sample taken and precipitated forms tough and nearly transparent flakes. It is practically equivalent to cellulose triacetate. The final product desired is a partially hydrated modification of this. An aqueous solution containing 50 per cent. of acetic acid is added to the syrup, the quantity varying according to the excess of acetic anhydride present, between 80 and 120 gms. per 100 gms. of cellulose.

Hydration occupies 12 to 16 hours at a constant temperature. Precipitation is effected by adding water to the syrup. The precipitate is washed acid free and dried at a low temperature (40 to 60 deg. C.). The product is soluble in acetone.

Acetic acid in the waste solutions is recovered as sodium acetate, and is used over again. The maximum quantity of sulphuric acid used is about 20 per cent. of the weight of cotton waste. The cellulose acetates as produced at present have a tendency to instability. The causes of this are under investigation. The quantity of acetic anhydride used is an important matter, and is controlled by many factors, *e.g.*, temperature, per cent. of moisture in cotton waste, and ratio of sulphuric acid to cotton waste.

Personal.

MR. J. B. HENDERSON, F.I.C.

Mr. J. B. Henderson, whose photograph appears in this issue, is the Government Analyst of Queensland, and a member of the Executive Committee of the Institute of Science and Industry. He received his early scientific training in Scotland, and was for two or three years Research Assistant to Dr. William Dittmar, Professor of Chemistry, Anderson's College, at Glasgow. During the period of their association, both Dr. Dittmar and Mr. Henderson were awarded the Graham Medal for Research for work on the atomic weight of hydrogen.

Coming to Australia in 1890, with the intention of commencing his profession as an analyst, Mr. Henderson found that the immediate prospect was not promising, and took a position as Science Master at the Brisbane Grammar School. It is a curious fact that three men closely associated with the Institute were at one time or another members of the teaching staff of this school. Professor Rennie, of the University of Adelaide, was one of these; Dr. Hargreaves, Government Analyst of South Australia, was another; and Mr. Henderson the third.

In 1893, Mr. Henderson was appointed Government Analyst of Queensland. Commencing with a staff of one messenger, in a small laboratory, the organization has grown until now it comprises a staff of ten qualified analysts, five juniors, with clerks and attendants, a library of nearly 2,500 volumes, and a chemical laboratory which is one of the best equipped in the Commonwealth. It speaks well for the standard of work performed that, in connexion with food analyses, not one case has been lost in the Courts through failure of chemical evidence.

Mr. Henderson has displayed keen interest in many questions of a public character. For many years he took an active part in the movement for the establishment of a University of Queensland; and when this Institution was established, he was appointed to the first Senate. Twice re-elected to that position, he still continues to be a member. He was a member of the Board of Technical Instruction, which preceded the present departmental control of technical instruction. Since 1890, Mr. Henderson has been a member of the Royal Society of Queensland, and on two occasions was elected President. Other prominent positions which he has occupied include President of Chemical Section of the Australian Association for the Advancement of Science, at Dunedin, 1904; Deputy Chairman of the Board of Advice on prickly pear destruction, which started the very important work on the lines since taken up by the Institute of Science and Industry. During the war, Mr. Henderson gave his efforts freely to patriotic movements, and acted as chairman of the local Munitions Committee; was a member of the Red Cross Executive; and was chairman of the Red Cross, Men's Auxiliary Section; besides being connected with several other war organizations. As chairman of the State Committee of the Institute of Science and Industry, Mr. Henderson has found further scope for his tireless industry and his scientific attainments, and he has contributed largely to the success of that organization since its inauguration.

REVIEWS.

Heredity and Evolution in Plants, by C. Stuart Gager. Pp. xiii.+265, with 113 illustrations. P. Blakiston's Son & Co., Phil., 1920. This book, which has been sent to us by the publishers, contains an excellent account of all the theories which have been advanced up to the present on the subject of Heredity and Evolution, especially with reference to plant life. The author, who is Director of the Brooklyn Botanic Garden, introduces two chapters, written in popular language, on the history of the fern, to provide a clear conception of the facts of the life-history of a typical vascular plant. This appears to be the only fault to be found, as the standard is not in keeping with the rest of the work. If the text is for advanced students—as the preface says that "Certain information pertinent only to an elementary text-book has been omitted"—then an elementary introduction was unnecessary. If the text is an elementary one—the preface again states that "The following pages shall prove to be a source of reliable and readable elementary information"—it is very much to be doubted that even this account will be sufficient to enable any person without some previous knowledge of botany to assimilate the information given in the following chapters. A chapter on Heredity generally is followed by one on the Experimental Study of Heredity, in which the simple facts of the Mendelian ratio and the tests by which it can be proved are explained. The value of its discovery and the unsolved problems in connexion with Mendelism are tabulated. Weismann's germ-plasm theory and its bearing on the inheritance of acquired characters is discussed. The next chapter treats of Evolution with its various hypotheses, a separate chapter being devoted to Darwinism. The solution of the problems left unsolved by Darwin were attacked by biologists in an experimental way, and the chapter on Experimental Evolution explains such methods, especially associated with the work of de Vries. The evolution of plants is then examined, and the evidence as to the course of evolution is taken from the comparative life-histories and anatomy of living forms, geographical distribution, and palæobotany. Chapters are devoted to each of these subjects. A lengthy comparison is drawn between the seed-bearing plants to be found in fossil records and the most primitive cycads of to-day. The final chapters give an account of the monophyletic and polyphyletic theories of the origins of modern plant orders, and the relationship between all the great groups of plants, both living and fossil. The book is particularly well illustrated throughout. There are many interesting photographs, drawings, and test figures, and some very instructive and original graphic diagrams. The photographs of the more prominent authorities on history and evolution add a personal touch. A useful bibliography is also included. Altogether, it would be difficult to find such an amount of information written in such clear and concise language, and right up to date, in any single book on this popular subject. Both author and publisher have carried out their parts well.

The Forests of Western Australia.—Persons interested in the forests and forest products and industries of Western Australia will find a great deal of information on these subjects in a handbook just published by the State Government, and compiled by Mr. C. E. Lane-Poole, Conservator of Forests. The author is to be complimented on taking this step to focus attention upon a matter of vital concern to Western Australia; for the book should prove a most effective instrument in developing a public consciousness of the close relationship that exists between the State's

economic progress and the intelligent treatment of the forest wealth. Commencing with a brief article on the significance of forests, he then deals with forestry as a science, forest capital and forest interests, forest policy, and various other political and economic phases of the industry. In the technical section of the publication Mr. Lane-Poole devotes a good deal of space to descriptions and uses of Western Australian hardwoods. The concluding sections contain much miscellaneous information about trees and timber useful to the bushworker and to countryman. Illustrations and tables contribute greatly to the value of the handbook. It is clear that the definite purpose of the author has been to arouse public interest in the vast work of repairing the havoc and the waste of the past and of economically exploiting the remnant forest riches, and in this he has been entirely successful.

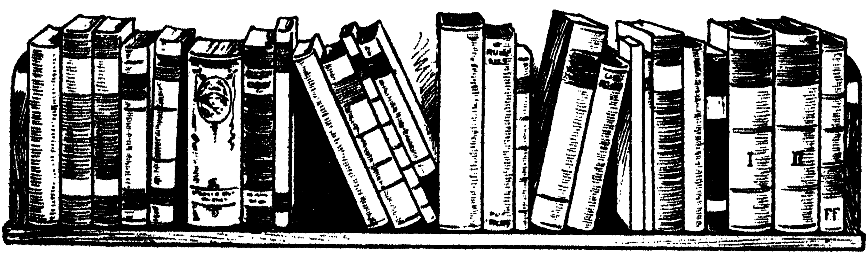
SOME PUBLICATIONS RECEIVED.

A Statement prepared for the British Empire Forestry Conference, 1920, by C. E. Lane-Poole. The statement includes brief notes on the most important timbers and forest produce of Western Australia, a description of the main types of forest growth, and various other matters relating to the forestry resources of the State. There are also several maps showing the habitat and general distribution of forest trees.

A Critical Revision of the Genus Eucalyptus, Vol. V., Part 2, by J. H. Maiden, I.S.O., F.R.S., F.L.S. The species described are *E. eximia*, *E. peltata*, *E. Watsoniana*, *E. trachyphloia*, *E. hybrida*, *E. kruseana*, *E. Dawsoni*, *E. polyanthemos*, *E. Baueriana*, *E. conica*, and *E. concolor*.

Under the authority of the Minister for Mines, Western Australia, the following memoirs have been published:—The Coal Deposits of Western Australia, the Antimony Deposits of Western Australia, the Tungsten Deposits of Western Australia, the Artesian Water Resources of Western Australia, the Lead Deposits of Western Australia, the Magnesite Deposits of Western Australia, the Iron Deposits of Western Australia, and the Copper Deposits of Western Australia, by A. Gibb Maitland; Assistance to Prospecting and Mining, by P. J. Atkins; Minerals of Economic Value, by E. S. Simpson, D.Sc., B.E., F.G.S., with an Appendix by A. Montgomery, M.A., F.G.S.; and Glossary of some Common Terms used in Mining, Field, and Physiographical Geology.

The Queensland Geological Survey, Department of Mines, has issued the following three articles on Industrial Minerals, by B. Dunstan, Chief Government Geologist:—Salt, Asbestos, and Mica. Occurrence, uses, treatment, &c., are described.



The following is a copy of the Act for the establishment of the Institute of Science and Industry.

No. 22 of 1920.

An Act relating to the Commonwealth Institute of Science and Industry.

[*Assented to 14th September*, 1920.]

BE it enacted by the King's Most Excellent Majesty, the Senate, and the House of Representatives of the Commonwealth of Australia, as follows:—

PART I.—PRELIMINARY.

Short title. **1.** This Act may be cited as the *Institute of Science and Industry Act* 1920.

Parts. **2.** This Act is divided into Parts as follows:—

Part I.—Preliminary.

Part II.—The Commonwealth Institute of Science and Industry.

Part III.—Powers and Functions of the Director.

Part IV.—Miscellaneous.

Definition. **3.** In this Act, unless the contrary intention appears—

"Institute" means the Commonwealth Institute of Science and Industry;

"Officer" means any person employed by the Director under this Act;

"The Director" means the Director of the Commonwealth Institute of Science and Industry.

PART II.—THE COMMONWEALTH INSTITUTE OF SCIENCE AND INDUSTRY.

4.—(1.) There shall be a Commonwealth Institute of Science and Industry, consisting of the Director, which shall be a body corporate with perpetual succession and a common seal and capable of suing and being sued. The Institute of Science and Industry.

(2.) All Courts, Judges and persons acting judicially shall take judicial notice of the seal of the Institute affixed to any document or notice, and shall presume that it was duly affixed.

(3.) The Institute shall, subject to this Act, have power to hold lands, tenements and hereditaments, goods, chattels and any other property for the purpose of and subject to this Act.

(4.) The Institute shall have power to acquire by gift, grant, bequest or devise, any such property for the purposes of this Act, and, in the absolute discretion of the Director, to agree to any conditions of such gift, grant, bequest or devise.

(5.) The powers of the Institute under the last preceding sub-section shall, subject to the regulations and the approval of the Minister, be exercised by the Director on behalf of the Institute.

5. The Institute shall establish— Constitution of Institute.

(*a*) a Bureau of Agriculture;

(*b*) a Bureau of Industries; and

(*c*) such other bureaux as the Governor-General determines.

6. The Governor-General may appoint a General Advisory Council and Advisory Boards in each State to advise the Director with regard to— Appointment of Advisory Boards.

(*a*) the general business of the Institute or any bureau thereof; and

(*b*) any particular matter of investigation or research.

7.—(1.) The Governor-General may appoint a Director of the Institute. Appointment of Director.

(2.) On the happening of any vacancy in the office of Director of the Institute the Governor-General may appoint a person to the vacant office.

(3.) The term for which such appointment is made shall be five years, and any person so appointed shall, at the expiration of the term of office, be eligible for re-appointment.

(4.) In case of the illness, suspension or absence of the Director, the Governor-General may appoint a person to act as Deputy-Director during the illness, suspension or absence, and the Deputy shall, while so acting, have all the powers and perform all the duties of the Director.

Salary and expenses of the Director.

8.—(1.) The Director shall receive such salary as the Governor-General determines.

(2.) The salary of the Director shall be paid out of moneys appropriated by Parliament for the purpose.

(3.) Travelling expenses as prescribed shall be paid to the Director on account of his expenses in travelling in the discharge of the duties of his office.

Suspension of Director.

9.—(1.) The Governor-General may at any time suspend the Director from his office for incapacity, incompetence, or misbehaviour.

(2.) The Minister shall, within seven days after the suspension, if the Parliament is then sitting, or if the Parliament is not then sitting, within seven days after the next meeting of the Parliament, cause to be laid before both Houses of the Parliament a full statement of the grounds of suspension.

(3.) A Director who has been suspended shall be restored to office unless each House of Parliament within forty days after the statement has been laid before it, and in the same session, passes an address praying for his removal on the grounds of proved incapacity, incompetence, or misbehaviour.

Director to devote whole time to his duties.

10. The Director shall devote the whole of his time to the performance of his duties, and shall not accept or hold any paid employment outside the duties of his office as Director or be a director of a company.

Part III.—Powers and Functions of the Director.

Powers and functions of Director.

11. The powers and functions of the Director shall, subject to the regulations and to the directions of the Minister, be—

(*a*) the initiation and carrying out of scientific researches in connexion with, or for the promotion of, primary or secondary industries in the Commonwealth;

(*b*) the establishment and awarding of industrial research studentships and fellowships;

(*c*) the making of grants in aid of pure scientific research;

(*d*) the recognition or establishment of associations of persons engaged in any industry or industries for the purpose of carrying out industrial scientific research and the co-operation with and the making of grants to such associations when recognised or established;

(*e*) the testing and standardization of scientific apparatus and instruments, and of apparatus, machinery, materials and instruments used in industry;

(*f*) the establishment of a Bureau of Information for the collection and dissemination of information relating to scientific and technical matters; and

(*g*) the collection and dissemination of information regarding industrial welfare and questions relating to the improvement of industrial conditions.

12. The Director shall, as far as possible, co-operate with the existing State organizations in the co-ordination of scientific investigation, with a view to—

(*a*) the prevention of unnecessary overlapping; and

(*b*) the utilization of facilities and staffs available in the States.

PART IV.—MISCELLANEOUS.

Arrangements with States.

13. The Governor-General may arrange with the Governor of any State for any of the following purposes:—

(*a*) the utilization for the purposes of this Act of State Research Departments and Laboratories and Experimental Stations and Farms;

(*b*) the co-operation in industrial and scientific research with State Government Departments, Universities and Technical Schools; and

(*c*) the co-operation with educational authorities and scientific societies in the Commonwealth with a view to—

(i) advancing the teaching of science in schools, technical colleges and universities where the teaching is determined by those authorities;

(ii) the training of investigators in pure and applied science, and of technical experts; and

(iii) the training and education of craftsmen and skilled artisans.

Appointment of Officers.

14.—(1.) The Governor-General may, on the recommendation of the Minister, appoint such officers as he thinks necessary for the purposes of this Act.

(2.) Officers employed under this Act shall not be subject to the *Commonwealth Public Service Act* 1902-1918, but shall be engaged for such periods and shall be subject to such conditions as are prescribed.

(3.) An officer of the Commonwealth Public Service or of the Public Service of a State who becomes an officer under this Act shall retain all his existing and accruing rights.

Discoveries by officers.

15. All discoveries, inventions and improvements in processes, apparatus and machines made by officers of the Institute shall be vested in the Institute as its sole property, and shall be made available under such conditions and payment of such fees or royalties or otherwise as the Governor-General determines.

Bonuses for discoveries by officers.

16.—(1.) The Director may pay to successful discoverers or inventors working as officers of the Institute or under the auspices of the Institute such bonuses as the Governor-General determines.

(2.) Bonuses payable under this section shall be paid out of moneys appropriated by Parliament for the purpose.

Fees and agreements for special investigations.

17. The Director may charge such fees and may agree to such conditions as he thinks fit for special investigations carried out at the request of any authority, institution, association, firm or person.

Annua report of Director.

18. The Director shall, once in every year, make a report to the Minister containing a summary of the work done and researches and investigations made and proceedings taken by the Institute during the preceding year.

Reports to be presented to Parliament.

19. The Minister shall cause the yearly report of the Director to be laid before both Houses of the Parliament within thirty days after the receipt thereof if the Parliament is then sitting, and if not, within thirty days after the next meeting of the Parliament.

Power to publish information.

20. The Director may publish such information relating to any matter investigated by him as he thinks fit, except where such publication would be contrary to conditions agreed to under section seventeen hereof.

Regulations.

21. The Governor-General may make regulations not inconsistent with this Act, prescribing all matters which are required or permitted to be prescribed or which are necessary or convenient to be prescribed for carrying out or giving effect to this Act, and in particular for prescribing such additional powers and duties of the Director as he deems desirable.

SCIENCE AND INDUSTRY.

VOL. 2.] OCTOBER, 1920. [No. 10.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Training Specialists for Industry.

AN arresting feature of the movement which is being energetically developed in Great Britain for the linking up of science with industry is the difficulty experienced in obtaining suitable officers to carry out scientific research. An important branch of the work of the Department of Scientific and Industrial Research is to encourage the organization of research associations for the immediate benefit of industries which are not under State management. To achieve this object, grants-in-aid are made under certain conditions and under articles approved by the Board of Trade.

Very little in the way of propaganda was needed to convince the various industries of the wisdom or of the urgency of establishing the machinery by which the various scientific problems which hinder economic development might be vigorously attacked. War had done all that was necessary in this direction. The dislocation of foreign trade revealed, in a flash, the dependence of Great Britain upon foreign countries for the supply of numerous commodities vital to the maintenance of her integrity. The manufacture of many of these had passed to alien hands, not because of any economic advantage which the countries enjoyed, but solely because of their adoption of more scientific methods.

SCIENCE AND INDUSTRY.

Now that the effort is being made to repair the neglect of the past, it is found that there is a shortage of trained men, whose services are essential to the attainment of industrial efficiency and to the restoration of lost trade. The present situation, however, merely furnishes another example of the working of the law of supply and demand. The restricted demand for the scientist in industry in pre-war days, and the beggarly pittance grudgingly given him, very effectually stopped the supply; and so it comes to pass that, in the new-born zeal for scientific research, there is a serious lack of men capable of doing the work waiting to be done. Owing to the small number of scientific men of high standing working for the advancement of special industries, it has become necessary in several instances for the research associations to make their own experts. To meet the immediate necessities of the situation, the best men available are being obtained, so that their scientific skill may be applied to industrial practice. To make provision for the future, the establishment of industrial research fellowships is being considered.

In Australia, the position, as regards the past, is much the same as obtained in Great Britain. In regard to the future, however, it is not so comforting. There is not yet in this country a general realization of the necessity for the utilization of the services of trained scientists, and the fact that their number is strictly limited passes without notice and without regret. Two years ago, the Institute of Science and Industry formulated a scheme for the establishment of research fellowships, and the main principles were warmly approved by specialists to whom it was submitted. Owing to the long-delayed establishment of the Institute it was impossible to do more than draft a scheme and await the time when its adoption by the permanent organization became permissible.

It may, therefore, be of interest, and perhaps of value, if the main provisions of that scheme are published. The principal object in view was to enable graduates who have passed through a university or higher technical school course in applied science, and who have shown promise of capacity for original research, to continue the prosecution of science with a view to—

(a) aiding its advance or its application to the industries of Australia;

(b) providing a supply of properly trained and qualified investigators.

At the time the idea was put forward it was suggested that the fellowships should be each of the value of £150 per annum; that they should be awarded, in the first instance, for one year only; and that their continuation for a second year should be dependent on the work

done during the first year being considered satisfactory by the Director of the Institute. It is quite evident, however, that if an opportunity is presented of proceeding with this scheme of training that a sum of £150 will be insufficient for necessary living expenses.

It was thought that the field of work could scarcely be too large, and it was proposed, therefore, that fellowships should be awarded in agriculture, botany, veterinary science, zoology, chemistry, engineering, geology (economic), metallurgy, and physics. Provision was to have been made in conferring this benefit that preference should be given, other things being equal, to graduates who selected some subject for research which was likely to be important to the industries of Australia or to the development of the natural resources of the country. It was further proposed that any person to whom a fellowship was awarded must either be a graduate in Applied Science or have received an equivalent training in an institution possessing adequate facilities of a scientific character for providing such training. The fellowships would be open to both men and women.

Following on the tentative adoption of the scheme, copies were circulated among twenty Professors and Lecturers at the various Australian Universities, with a request for brief comment. Each of the nineteen replies received indorsed the general principles laid down. Naturally, there was division of opinion as to the amount of the annual allowance, and the sum of £150 was generally regarded as inadequate. It is a simple matter, however, to harmonize the differences of opinion on this point. The important thing is that the trained educationist and scientist are in complete agreement on the main principles, and that they regard the adopton of some such scheme as a matter which should not be much longer delayed.

Primary and secondary industries alike need all the assistance that science can render them, and if they are to be developed to the full extent of their possibilities, trained men will be required to solve those problems which are already impeding progress, and to dispose of others which are bound to arise as onward stages are reached.

E. N. R.

EDITORIAL

GREEN MANURES FOR CITRUS FRUITS.

A summary is given in the *Experiment Station Record*, vol. 42, 24th June, 1920 (pages 830-831), of horticultural research during the three years ended June, 1919, carried out at the California Experimental Station. The fertilizer experiments with citrus fruits begun in 1907 have been continued by H. J. Webber and his associates at the citrus sub-station. Uniform treatments have now been under way twelve years. The results, thus far secured, continue to emphasize the great importance of organic matter and nitrogen, and the comparative slight importance, on the soils included at least, of phosphoric acid and potash. The plats treated with stable manure and raw rock phosphate, on which a leguminous winter cover crop is each year grown and ploughed under in early spring, continue to be superior to those otherwise treated. Plats treated with chemicals, such as nitrate of soda alone, or in conjunction with sulphate of potash, superphosphate, and dried blood, have gradually deteriorated, showing increased quantities of mottle leaf, and are now much inferior to plats that have received organic matter. In an experiment conducted to determine the best methods of rejuvenating an old citrus grove, the trees on two plats receiving manure and summer cover crops seemed to have improved more in general appearance than the trees on any other plat, although other methods of treatment here noted resulted in larger yields of fruit. Further studies on the use of green manures in citrus groves continue to emphasize the importance of this practice, bitter clover (*Melilotus indica*) and purple vetch (*Vicia atropurpurea*) giving the most satisfactory results when used as winter cover crops. Preliminary trials of another vetch, *V. dasycarpa*, have also given excellent results. The purple vetch is proving very desirable for use, especially on light sandy soils, where in some cases it has been found difficult to get a good stand of bitter clover. A feature that has been brought out in the recent experiments is the importance of using green manures in young groves to improve the soils while the grove is developing. In a seventy-acre grove planted at the citrus sub-station in the spring of 1917, black-eye beans have been grown between the trees each summer, and bitter clover sowed broadcast over the entire area in the winter. The beans have more than paid for the cultivation of the grove, and the bean straw and clover has been returned to the land. Under this treatment the grove has made a remarkable growth with no other fertilizer.

THE EFFECTS OF ALKALI ON CITRUS TREES.

In a bulletin issued by the California Experimental Station the authors report the result of a survey of several citrus groves in different localities of Southern California, to determine the effects of alkali, preliminary to a study of methods of combating alkali. The results of this survey are discussed and related studies briefly reviewed. In lieu of more definite information some general suggestions are given for the treatment of injured groves. Severe alkali injury was observed in a number of citrus groves in several districts, and a large percentage of this injury was due to irrigation water. Chlorides were the most injurious constituents of the waters, although in certain localities some of the waters also contained injurious amounts of sulphates and carbonates. The irrigation supplies rarely contained enough alkali to harm citrus trees directly, but the injury was due to the concentration of salts after a variable period of years, depending on the nature of the soil, the amounts of alkali in the water and soil, rate of evaporation, &c. Alkali injury was also brought about in an experimental plot at the citrus sub-station by repeated large applications of nitrate of soda. Examination of the nature of alkali injury showed that an excess of chlorides causes the tips and margins of citrus leaves to become yellow or brown, followed by defoliation. Sometimes a large portion of the leaves fall, and the young, tender shoots may be killed. An excess of sulphates and bicarbonates, on the other hand, is more likely to stunt the growth of the trees and cause the leaves to become chlorotic. More or less mottle leaf may also occur. Lemon trees are apparently injured by lesser amounts of alkali than oranges. The effects of alkali are intensified by the puddling effect of continued irrigation with waters containing sodium salts, particularly those containing sodium carbonate and sodium bicarbonate. Under such conditions the alkali cannot leach down beyond the citrus roots. It is especially important to keep the soil open and porous where nitrate of soda or saline irrigation water is used in regions of light rainfall. To accomplish this, the use of deep-rooted cover crops and ploughing under organic materials such as manure or bean straw is recommended. When saline water is the only source of irrigation, the use of the basin or flooding systems instead of the furrow system of irrigating may afford temporary relief from alkali injury in case the subsoil drainage is satisfactory. By increasing the alkaline content of the drainage water, however, the ground water may ultimately become heavily charged with salts. Observations made in one district showed the most effective treatment for injured groves to consist of thorough tillage, ploughing down manure, and the application of irrigation water free from alkali.

MANURING FOR MILK.

Experiments extending over several years, conducted at the Clonakilty Agricultural School in Ireland, in which cows were tested on manured and unmanured pastures, are reported in the *Experiment Station Record.* The experiment consisted in the estimation of the improvement in pasture following the application of basic slag and other fertilizers, in terms of milk yield, the results being obtained by grazing milch cows, and comparing the yield of milk produced with that

of similar cows grazed on an equal area of the same pasture unmanured. The results of these experiments demonstrated that manuring for milk is profitable, and that the carrying capacity for cows of a poor pasture can be considerably increased by manuring. It was found that on the poor pastures tested it was possible for cows in milk to more than pay the cost of the basic slag in the first season after application by reason of the greater number of cows carried. Particular attention is drawn to the fact that the advantage gained by manuring poor pastures lies not so much in the individual increase in milk yield per cow as in the additional carrying capacity of the pasture.

SUDAN GRASS.

Ten years after its introduction to the United States from Khartoum, Africa, Sudan grass was being successfully grown in nearly all parts of the United States, states the *Weekly News Letter*. It does not serve well either as a "money crop" or a soil improver, hence it may never find a permanent place in regular crop rotations. It has, nevertheless, a very important place in the farmer's second line of defence as a catch crop, which can be planted to give satisfactory returns when conditions have brought failure to other hay crops. This is the verdict pronounced by the United States Department of Agriculture in the Farmers' Bulletin 1126 recently issued.

Sudan grass is replacing millet as the premier catch crop in many localities, because of its ability to produce a fair yield and a high quality of hay under conditions of low rainfall, its rather short growing season, and its ability to thrive on a wide range of soil types. Large yields of Sudan grass are obtained only on good soils, but the grass fails completely only on cold, poorly drained land.

Sudan grass produces heavily. In California, under irrigation, it has made yields of 9.8 tons of field-cured hay an acre, when alfalfa produced but 8.3 tons under like conditions; it ordinarily yields about the same as alfalfa under irrigation in the South-west, but Sudan grass gives its full crop in three cuttings against the four or five required for alfalfa. It is the only grass yet found which, in this part of the United States, ranks as the equal of alfalfa in point of yield and quality of the hay. Its record, in this respect, has led to its use in "patching" old alfalfa fields when the stand of alfalfa has been destroyed. In the Southern Great Plains, where there is a low rainfall, Sudan grass grown without irrigation will yield from one to three tons of hay to the acre.

There are certain parts of the United States where the Department of Agriculture considers it unwise to depend on Sudan grass for hay. This is true of the strip of territory 200 miles wide along the northern boundary; the regions of high altitudes in the Western States; and also most of Florida and a narrow strip of land along the Gulf coast. Low temperatures prevent success with the grass in the first two regions named, and disease is the limiting factor along the Gulf coast. In a majority of the Central and Southern States, however, climatic and soil conditions are favorable to Sudan grass.

Although Sudan grass is best adapted by nature to use as a hay crop, it is also used with great success as a soiling and pasture crop for

summer pastures. Its use as a silage material is limited by the fact that it is easily made into hay and fed as such with very little waste, and also because corn and sorghum both out-yield it and are generally available throughout the region where Sudan grass is grown.

In the semi-arid districts the highest yields are obtained when the grass is sown in rows, so as to allow of cultivation. The advantage in yield of the row over the drilled seedlings is so small, however, that most farmers prefer to avoid the necessity of cultivation by drilling or broadcasting the seed. A common grain drill handles well-cleaned Sudan grass seed without trouble, and the hay from drilled seedings is finer stemmed and matures more evenly than row plantings.

The feeding value of Sudan grass is equal to timothy hay. In localities where soy beans or cowpeas do well these legumes may be grown in mixtures with the Sudan grass. Such a mixture produces a hay of higher feeding value than the grass alone because of the high protein content of the legumes.

Sudan grass hybridizes freely with the sorghums. It is necessary, therefore, if pure seed is produced, to have the Sudan grass field at some distance from any sorghums, otherwise it will result in a mongrel crop the following year.

PRACTICAL FUEL ECONOMY.

The Federation of British Industries has decided to start a fuel economy scheme, under the direction of an Expert Committee, consisting of technical representatives of firms belonging to the Federation, who have specialized in the question of efficient and economical fuel practice in various branches of industry. The committee is composed as follows:—Professor Bone, D.Sc., F.R.S., Ph.D. (Chairman); Mr. A. W. A. Chivers (British Electrical Federation), Mr. F. G. Fryer (Messrs. Rowntree and Company Limited), Sir Robert Hadfield, Bart. F.R.S. (Messrs. Hadfields Limited), Mr. Henley L. Howard (General Electric Company Limited), Mr. E. W. L. Nicol (National Gas Council), Mr. H. Stafford Rayner (Messrs. Sir W. G. Armstrong, Whitworth and Company Limited), Mr. H. James Yates (Messrs. John Wright and Eagle Range Limited), Mr. Holbrook Gaskell (United Alkali Company Limited). The *personnel* of the committee is a sufficient guarantee that the activities of the organization will be conducted upon most scientific and practical lines.

The work of the committee will be confined in the first instance to gas producing and steam raising plant. Its activities will probably fall into two main divisions: first, the assistance of individual firms, and second, the assistance of organized trades. The committee is collecting a large amount of information, which has never before been brought together, in regard to the fuel requirements of the great industrial centres and of the different industries of the country. Moreover, the very intimate relationship, which the Federation has established with the Government departments and other representative bodies concerned, will enable it to protect manufacturers' interest in regard to supply in a way which has never hitherto been possible. It may also be necessary for the committee to take into consideration on behalf of the members of the Federation such national subjects as coal conservation,

smoke abatement, and any other subject directly bearing on the fuel problem as affecting industrial consumers. There is already plenty of evidence of the importance which British manufacturers attach to the question of Fuel Economy, and there is little doubt that the new department of the F.B.I. will quickly receive many applications for assistance.

WHERE THE GERMANS GOT GLYCERINE.

Where the Germans got the glycerine for the manufacture of high explosives was one of the mysteries of the last two years of the war. It was a puzzle, not merely to the British Government, one of whose members made the belated announcement that glycerine could be derived from lard, but to English chemists who were aware that fats, of which lard was one, were the sole substances from which glycerine hitherto had been derived. We had closed down by the blockade the entrance to Germany of fats from the outside, and during 1917 and 1918 it did not seem possible that she could have fats enough to keep her population alive and furnish the glycerine for explosives as well. Somehow, she was managing. Yet, theoretically, she ought not to have been able to do so, and a circumstance which supported the theory, though it was contradicted by the facts, was that she appeared to have no soap. Soap is also made out of fats. In short, she evidently was short of fats; yet she had the glycerine.

The contradiction could only be reconciled on the supposition that she was getting glycerine out of something other than fat. That is exactly what she was doing, and the story of how she did it is one of the curiosities of research. The story begins with Pasteur. Many years ago the great Frenchman's work explored the splitting up of the cells of substances by enzymes, or, to use a simpler word for the purpose of this argument, the power of yeasts. By yeasts, the cells of sugar can be split up into alcohol and carbonic acid gas. All these are simple substances, yet nothing except these powerful yeast enzymes will do the conjuring trick. Long after Pasteur's classic researches, both while he was living and after he was dead, chemists sought to find the key of mechanism whereby this wonderful transformation is effected. In connexion with the transformation there are two side products. Besides the alcohol and the carbonic acid into which the sugar is split, there was always a small quantity of acetic aldehyde, and, still more mysterious, a minute quantity of glycerine. The quantity of glycerine was proportionately very small.

"A PURELY ACADEMIC PROBLEM."

The aldehydes are the substances which lend flavour to the various forms of drinkable alcohol; so that from an industrial point of view there might have been, though there was not, some profit in following them up. But that was not the research chemist's incentive. He continued to investigate the acetic aldehyde, which might be expected to vary according to the amount of oxidation which the alcohol underwent; and also to probe that surprising appearance of glycerine, because these phenomena might afford some explanation of the way the transformation was worked. It was, you might say, a purely academic problem,

on which the governing bodies even of research institutions were inclined to frown, because it appeared to lead to nothing profitable. Dr. Harden, in London (and at the Lister Institute as a matter of record), had done a good deal with the problem up to the outbreak of war, and his researches were well known to the German chemists. Among the ramifications of his researches it became known that of the transformations into alcohol and carbonic acid, acetic aldehyde and glycerine were effected in the presence of certain sulphides, and the amount of acetic aldehyde left after the conversion was much increased. The fragmentary quantity of glycerine increased with it.

The German chemist Neubauer vigorously prosecuted the inquiry from this point during the first two years of the war. He prosecuted it to such valuable effect that the 20 per cent. of acetic aldehyde which could be got was still further increased, the glycerine increasing with it, and, to cut a long story short, eventually the amount of glycerine that could be got out of sugar was no less than 30 per cent. That is where the Germans got their glycerine during the last years of the war, and that is why, though Germany is a country which used to export £11,000,000 of sugar a year, they were short of sugar for domestic purposes. If it had not been for this chemical reaction, the fruit of an inquiry pursued solely for the sake of knowledge by a few isolated chemists, Germany would have had to go out of the war after the first two years of it.—*The Chemical Age.*

CONSERVATION OF MOLASSES.

Among the sources of alcohol that lie ready to hand is its distillation from molasses, the chief residue of sugar manufacture. The present seems an ideal opportunity, not only to stir up the Government to encourage the use of molasses alcohol in industry, but also to educate sugar planters and others in the British Empire into the possibilities of using their surplus molasses in a new and profitable manner. At present the British West Indies can probably utilize all their molasses for rum manufacture; but the demand for rum will slacken off before long, especially with the spread of prohibition in America and elsewhere; so rum manufacturers cannot indefinitely count on a bumper trade such as the war period gave them. But the whole question is one that might with advantage be investigated by a central body on behalf of planters and distillers, and it should not be left to the Board of Trade alone to undertake this. We suggest, then, that this is a subject that might be advantageously taken up by the British Empire Sugar Research Association. If this body would give the problem its early attention, and investigate all the possibilities, it might be in a strong position, not only to make representations to the Government, but also to direct the planters generally, as to the best steps to take to ensure a permanent use of their waste molasses. But it may be advisable, first of all, for planters to indicate their willingness to be guided by such a body; they would do well, then, to come forward and request the British Empire Sugar Research Association to organize research on their behalf, so that the Association may have some assurance of possessing a mandate.—*The International Sugar Journal.*

FUEL OIL BECOMING SCARCE AND EXPENSIVE.

Failure of existing and prospective oil-fields to maintain equality of production to the consumption of petroleum products has been predicted by reliable authorities. The truth of this is already becoming apparent, and the situation is acute in certain parts of the country. In March of this year, states *Chemical and Metallurgical Engineering*, the Standard Oil Co. (California) increased the price of fuel oil 25 cents per barrel, and of gasoline 2 cents per gallon, at the same time paying an additional 25 cents per barrel for crude oil at the wells. In announcing this advance, the company stated that an increase in prices was the only known and tried means at its disposal that would bring about an increased production of crude oil, prevent the shipment of fuel oil and gasoline to competitive markets, and at the same time restrain demand. In January, 1920, the output of California's refineries amounted to about one-tenth of the gasoline and one-quarter of the fuel-oil production of the United States. It is but a question of time until conditions such as now exist in California will be reflected throughout the country, and ultimately result in becoming a question of national importance, since there is now lacking an adequate means of effectively combating the situation. Power derived from fuel is becoming increasingly expensive, and the consumer of power so obtained must face an uncertainty in the supply, this being particularly true of that from fuel oil. Recent experiences, the result of strikes affecting transportation and the production of fuels, have brought this forcibly to attention. In establishing new industries, the source of power and the effect of increased consumption on the future costs are factors which must be given consideration; more particularly will increased power costs adversely affect electro-chemical interests.

POWER ALCOHOL.

With every prospect of transport rates and passenger fares rising above their present levels, it becomes more and more imperative that some cheap form of liquid fuel should be developed. There seems little likelihood of petrol coming down in price so long as the demand exceeds the supply, and the only alternatives to which we can turn are home-produced benzol and power alcohol. About twelve months ago great hopes were entertained of benzol, but the position has been completely changed by the refusal of the Parliamentary Committees, which have recently been dealing with the Gas Regulation Bill, to enforce the recovery of benzol from coal gas. The motorist probably has never quite understood the fact that, in order to make a profit out of the process, not even the largest gas undertaking can afford to sell "stripped" benzol at the price prevailing to-day, particularly when consideration is given to the fact that town gas is, in the future, to be sold on a thermal instead of on a volume basis. The result is that the benzol which will be available for fuel purposes will be no more than that washed from coke-oven gas and produced from tar. As the quantity derived from these sources must necessarily be trifling compared with the total consumption of petrol, it would seem that the one remaining hope now lies in the development of power alcohol.

EDITORIAL.

Sir John Fowler, in *The Times'* trade supplement, insists that the production of power alcohol is not a question which admits of being dallied with; and, unless a decision is arrived at quickly, Great Britain will be forestalled in overseas markets for the raw materials for the manufacture of alcohol. The reasons why the use of power alcohol has not progressed in this country are Customs and Excise restrictions, the cost of production, apathy and want of foresight on the part of the Government, and regulations strangling the initiative of producers. Most unfortunately, from the point of view of its use as a fuel, alcohol is also an essential component of the beverages from the taxation of which considerable revenue is derived. Sir John says that, to give our industries the benefit of a competitor with petrol, all that is required is that a suitable denaturant be approved; that any duty on import should be removed; and that the regulations for the distribution and use of power alcohol should be as inexpensive and as free as is compatible with reasonable protection of revenue and safeguards against misuse. It is essential that the regulations shall be drawn up in a broadminded spirit by practical men, and not made so irksome as to defeat the whole object of giving us cheap liquid fuel.

The Fuel Research Board appointed by the Department of Scientific and Industrial Research, Great Britain, has issued an interim memorandum, in which reference is made to the difficulties of obtaining locally sufficient supplies of raw material for the manufacture of power alcohol. In a brief review of the present position it is pointed out that the production of alcohol in any considerable quantities from vegetable materials grown in the United Kingdom is not economically possible, owing to—(1) insufficient acreage; (2) the high cost of cultivation and harvesting; (3) the high cost of manufacture; and (4) the fact that the most suitable raw materials are also important foodstuffs. There is, for these reasons, no prospect of replacing any considerable quantity of petrol by home-produced alcohol. The cultivation of plants containing starch or sugar within the Empire is being investigated; but, even in the event of it being possible to produce alcohol in the British Dominions and Colonies at a price at which it could be imported, distributed, and sold in Great Britain, it must be a matter of time before supplies in any great quantity could be available. However, having regard to the future, some of the legislative questions which arise in connexion with the use of alcohol for power purposes have been dealt with in the Finance Bill. One important point is that the Board of Customs and Excise is given power to make regulations as to the composition and quantity of a denaturant for "power methylated spirits," and a denaturant will shortly be authorized which it is hoped will reduce to the minimum the cost of denaturing spirits to be used for this purpose.

ITALY TO USE EXPLOSIVES IN AGRICULTURE.

With a view to disposing of the surplus supply of explosives, and at the same time benefiting agriculture, a series of experiments has been conducted by the Italian Ministry of War in connexion with the breaking of ground. The results have been so satisfactory, states

Chemical and Metallurgical Engineering, that it has now been determined to proceed to the practical use of explosives in agriculture on a large scale. In addition to preparing the land for cultivation, it is claimed that the use of certain explosives not only destroys parasites, but also, to a certain extent, reduces the necessity for fertilization. It is proposed to establish in all districts of Italy demonstration fields where trials of the system which has been adopted will be carried out; such fields have already been created in Umbria, Puglia, Tuscany, and the liberated provinces. At the same time, the Ministry of War will turn over the large quantities of available explosives at favorable prices.

LIGNITE CARBONIZATION RESEARCH PLANT.

The United States Bureau of Mines has completed arrangements for a co-operative plan to carbonize lignite, and develop the necessary information that it is hoped will "make possible a favorable technical and business report which shall stimulate duplication of such plants throughout lignite areas." To this end a co-operative agreement has been made between the Bureau of Mines and Messrs. J. B. Adams and F. Bremier, under which an appropriation of £20,000, and an additional £40,000, which is to be furnished by Messrs. Adams and Bremier, will be used for the construction of the plant required and as a working capital for its operation. The plant will be installed at New Salem, N.D. The plant contemplated will consist of a battery of ovens of new form, which have been designed by the engineers of the Bureau of Mines, under the direction of Mr. O. P. Hood, Chief Mechanical Engineer. This battery will, it is estimated, coke at least 100 tons of raw lignite per day, and provide for complete recovery of the liquid and gaseous by-products, as well as for the handling of the char, from which it is planned to produce briquets. The briquetting plant will also be of special design, and it is to be an integral part of the plant, so that the char will be handled direct from the battery to the briquetting machine hoppers.

NEW BRITISH DYE.

After experiments extending over a period of two years it is reported, says the American Chamber of Commerce in London, that the British Dyestuffs Corporation Ltd. has now discovered, at its Huddersfield laboratories, the secret of manufacturing alizarine cyanine green dye on a commercial scale. This green dye was first discovered in Germany at the works of Bayer & Co., in 1894, and was manufactured exclusively by Germany before the war. The exact chemical details were jealously guarded, and no information was given to chemical associations, or allowed to appear in German technical journals. The special characteristics of the dye are that, when applied to wool, chromed or unchromed, fine green shades are produced which remain fast. Since the outbreak of war, woollen manufacturers have not been able to produce varying shades with the fastness of this dye, which is used particularly for tweeds and ladies' dress goods.

LOW TEMPERATURE CARBONIZATION LTD.

The *Chemical Age* reports the formation of a company in Great Britain for the low temperature carbonization of coal, which is issuing 250,000 £1 shares at par. The total share capital is £1,200,000, equally divided into 7 per cent. participating preference shares and ordinary shares of £1 each; and 570,921 of the former and 226,910 of the latter have already been issued. There has also been issued £145,027 of 6 per cent. first-mortgage debenture stock, out of an authorized total of £150,000. The principal object of the company is the erection and operation of works for the carbonization or conversion of raw coal by the special process of the company into motor spirit, fuel oil, smokeless fuel, sulphate of ammonia, and gas. Important contracts, it is stated, have been secured with the Yorkshire Electric Power Company, the Sheffield Corporation, and Steel, Peech, and Tozer Ltd., Sheffield; while negotiations have been completed and agreements are in course of preparation with one of the largest steel-makers in Scotland, and an important group of manufacturers on the Clyde. A considerable portion of the machinery and plant required for carrying out the contract with the Yorkshire Electric Power Company has already been erected at Barnsley by a concern whose shares are owned by Low Temperature Carbonization Ltd. From this plant gas is supplied to the power company under the contract with that company, and is used for burning under the boilers of their electricity generating stations. Great saving is thereby effected in working costs through the avoidance of all waste of the products which would otherwise be carried away as smoke. It is estimated that 1,000,000 tons of coal per annum will be carbonized in connexion with the above contracts, which involve the supply of approximately 7,000 million cubic feet of gas. In addition, the following products will be available for sale:—Motor spirit for motor cars and aeroplanes, about 3,000,000 gallons per annum; fuel oil, suitable for Navy, and ship's fuel, about 16,000,000 gallons per annum; smokeless fuel for domestic use, about 700,000 tons per annum; sulphate of ammonia, for fertilizers and high explosives, about 9,000 tons per annum. The proceeds of this issue will be devoted to the completion of the Barnsley works to an extended capacity of 175,200 tons of coal per annum and to the general development of the company's business.

ALTERNATIVE MOTOR FUELS.

Examining the possibilities of coal as an alternative source of motor fuel, the Fuel Research Board points out that, even from the world point of view, coal must remain by far the most important source of heat and power; for, while there are, no doubt, great undeveloped sources of natural oil, these cannot for a moment be compared in extent with the undeveloped coal deposits which are known to exist, or which can be estimated from geological surveys with a degree of certainty, which does not apply to similar estimates of the possible occurrence of oil deposits. Summing up the position as regards coal as a source of motor fuel, the Fuel Research Board states that—(1) Coal is the largest, as well as the cheapest, source of fuel for transport purposes. (2) Means are already in our hands for the "sorting out"

of the potential energy of coal into forms of different availability and of different commercial value. (3) The more volatile forms, like benzol and light naphtha, are so relatively costly that they ought only to be used for air transport, or for the lighter and swifter forms of road transport; their use for the heavier forms of transport is wasteful and unnecessary. (4) Town gas and coke-oven gas are available in large quantities in most parts of the country, and might be extensively used in omnibuses and passenger cars for quick traffic, if light and yet safe containers could be constructed, and if stations were established on the principal routes at which the containers could be quickly and easily replenished. If carbonization of coal at temperatures about 600° C. becomes common, gas of twice the calorific value of town gas would be available for this purpose, so that twice the thermal units could be carried in the same containers. (5) The coke produced by the carbonization of coal at 600° C. is a tarless smokeless fuel, easily lighted, and easily kept alight, and would be admirably adapted for use in suction-gas producers and engines. The cost of the thermal units produced in this way would not exceed 3s. per million, or one-seventh of the cost of petrol units with petrol at 3s. per gallon.

The United States of America Bureau of Mines has completed arrangements for a co-operative research on the carbonization of lignite. A sum of £40,000 is to be supplied by private interests for the erection of a research station at New Salem, North Dakota. The bureau will be in charge of the technical and experimental side of the investigation.

The United States of America Congress has passed an Act providing a sum of £86,000 for salaries at the Bureau of Standards at Washington, together with many special research items, of which the following are examples:—Fire-resisting properties of building materials, £5,000; development of colour standards, £2,000; optical glass, £5,000; metallurgical research, £5,000; sugars and sugar-testing apparatus, £6,000; high temperature measurement and control, £2,000; total for the Bureau, £243,500.

Sugar-Cane and its Cultivation.

By H. T. EASTERBY, General Superintendent, Bureau of Sugar Experiment Stations, Queensland.

Authorities in general are doubtful where the sugar-cane plant originated, but the probability is that India was its first home. It is mentioned in the ancient literature of that country as having been stated to have been created as a heavenly food. In the sacred books of the Hindus, the following occurs:—

> "I have crowned thee with a shooting sugar cane so that thou shall not be averse to me."

Sugar cane is repeatedly mentioned as being presented by way of tribute to different Emperors of the East, according to Geerligs.

The word "sugar" implied at one time anything sweet, such as honey, sugar of lead, fruit sugar, &c. The Indian word is "sarkara," while the Persian is "schakar." Other forms are "sukkar" (Arabian), "suickar" (Assyrian), "saccharum" (Latin), "azucar" (Spanish), "sucre" (French), and "zucker" (German).

The first statements as to the manufacture of sugar, which was then merely concentrated cane juice, do not appear till between the fourth and seventh centuries; but from that time the manufacture of sugar from cane spread rapidly in the East, and travellers to China in the thirteenth century found many factories there; and the manufacture of sugar gradually spread over the world in its tropical and sub-tropical zones.

Sugar cane belongs to the graminaceæ, or grasses. Its botanical name is *Saccharum officinarum*, but it is sometimes called *Arundo saccharifera*. It is considered by botanists that all the cultivated varieties belong to one species, but there are said to be strong reasons for the belief that there are more than one species.

These have been divided as follows:—

1. The kind known as *Saccharum officinarum*.
2. *Saccharum violaceum*, being canes with violet leaves, of which we apparently had an example in this country in a cane introduced from New Guinea by Mr. H. Tryon, known as N.G. 64.
3. *Saccharum sinense*, Chinese cane. Stubbs says the chief specific difference is said to reside in the disposition of its panicle, which, unlike that of the *Saccharum officinarum*, is oval and ornamental. This species would probably include the Uba or Yuban cane so extensively grown in South Africa. Other divisions have also been made by botanists.

Varieties of cane naturally embrace slight to extreme variations. The variation between the two principal varieties grown in Queensland, viz., Badila and Demerara 1135, is shown in the following brief descriptions:—

BADILA OR NEW GUINEA 15.

A dark-purple to black-coloured cane. Stout sticks, with pronounced white waxy rings at nodes. Internodes usually 2 to 3 inches long, but

sometimes longer, especially in ratoon cane. Habit erect; foliage also somewhat erect and very green. Eyes generally full and prominent. Trashes easily. Sparse arrower. The foliage of very young cane has a slight reddish tinge. Flesh white and highly saccharine. A remarkably heavy cane, weighing 1 lb. per foot. Greatly appreciated by labourers as it is so easily cut, trashed, and loaded.

Demerara 1135.

A brownish-red cane, of moderate stoutness, and a strong ratooner. Erect in habit, so that it is eminently suited for close planting. Joints about 4 inches long, parallel-sided. Foliage rather light in colour, sparse, and upright. Arrows freely in the north.

From the beginning of the cultivation of the cane in Queensland, it is estimated that quite 1,000 different varieties of cane have been introduced, while several thousand seedlings have also been raised. The number of varieties in commercial use to-day, however, may be stated to be about 45; but by far the greatest amount of cane grown consists of the two varieties Badila and D. 1135 mentioned above. The former is the favorite on northern cane areas, the latter in the south.

The chemical analyses of these two varieties from a milling point of view may now be given.

Variety.	° Brix.	Sucrose in Juice.	Purity of Juice.	% Fibre.	% Commercial Cane Sugar.
Badila	23.0	21.96	95.47	9.62	18.20
D.1135 ...	19.47	18.06	92.70	11.00	14.50

Sugar cane grows as high as 10 to 15 feet, and stalks as long as 27 feet have been measured. Some varieties are erect in habit, as are the two just mentioned, while others incline to "lodge" or assume a recumbent position when heavy, or they may be blown over by high winds. The roots are fibrous and lateral, and the majority of varieties are comparatively shallow rooters; but some are known as "deep-rooting canes."

The stalk is cylindrical, and is composed of what are known as "nodes" and "internodes." The nodes carry what are termed the "eyes" of the cane placed on alternate sides, and it is from these "eyes" that the cane is generally propagated. The leaves are alternate and opposite, and vary in length and width. The Badila cane has large, semi-drooping foliage, while the foliage of D. 1135 is narrow and erect. The leaves clasp the stalk for some inches and then recede, and when mature fall off, forming what is known in the cane-fields as "trash." When the cane plant is mature, it throws up what is termed an "arrow," which develops a panicle of flowers. Within recent years, the true seed of the cane plant has been discovered in the panicle, and the canes that have been grown from this seed are termed "seedlings." Cane does not arrow universally in Queensland; it does so far more frequently in the north than in the south, and there appears no doubt that climatic influences play a large part in the matter.

If a cane stalk be examined, there will be found at the node several rows of dots. These produce the roots when that portion of the cane is planted in the ground.

The cane stalk consists of an outside hard rind, with soft tissue inside, with thin-walled cells in which are stored the sugar. Harder fibre vascular bundles are also found. The leaves are manufacturers of sugar, and pass the material into the stalks. Chemically, the cane contains sucrose, reducing sugars, water, fibre, ash, gums, various inorganic and organic acids, nitrogen and non-nitrogenous bodies, &c.

Sugar cane is essentially a tropical plant, and does best in tropical areas. The cane areas of Queensland situated north of the tropic are, therefore, best adapted for the production of sugar.

When, however, the growth of sugar was first attempted in Queensland, it was for a time wholly confined to districts near to Brisbane. The first sugar cane grown in Australia, and the first sugar manufactured therefrom, appears to have been in New South Wales, it having been stated in a Report on the Sugar Industry, made in 1880, by Mr. Henry Ling Roth—to whom I am indebted for many of the following details—that, as far back as 1823, Mr. Thomas Scott, under the patronage of Sir Thomas Brisbane, succeeded in growing sugar cane at Port Macquarie, in New South Wales, and manufacturing 70 tons of sugar. Mr. Scott worked hard, both practically and by ventilation of the subject in local newspapers, to prove that sugar could be manufactured in that colony.

A short *résumé* of the early history of sugar cane in Queensland may not be out of place.

In 1849, proposals were made for the formation of a sugar company in South Brisbane, and there is said to have been a small plantation at Eagle Farm, on the Brisbane River, but apparently no sugar was made. Sugar cane was cultivated in the gardens of several people in Brisbane about this time, and a considerable amount was also grown in the Government Botanical Gardens. The first sugar produced in Queensland, according to Mr. Walter Hill, at one time in charge of the Botanical Gardens, Brisbane, was made as follows:—Sugar cane was taken from the Botanical Gardens in December, 1859, and passed between two steel rollers. The juice was taken back to the Gardens, and about 6 lbs. of sugar were made in a copper vessel. The first sugar made in Queensland of which there is any official record was manufactured by Mr. John Buhot, in 1862. In 1863, Captain Louis Hope had 20 acres under cane on Ormiston plantation, near Brisbane, and that gentleman is generally conceded to be the father of the Queensland industry. In 1863, the London Society of Arts offered a medal for the first ton of sugar made in the colony. The first sugar-cane plants were most probably imported from Java and Mauritius; and about this time the Queensland Acclimatization Society took active steps in bringing over a large number of varieties. A tremendous impetus was given to the industry when land was made available for some years by the Government on remarkably easy terms for sugar-growing; and in 1865 as much as 18,290 acres had been taken up ostensibly for cane planting. Shipments of cane were this year made to New South Wales farmers for planting.

By the end of 1867, there were nearly 2,000 acres under cane, and six mills had been erected which, between them, manufactured 168 tons of sugar. There was, however, an insufficiency of mills, which caused heavy losses to the farmers; but mill-owners did well, as they could buy cane for 4s. a ton.

Up to this time, the industry had been carried on entirely in southern Queensland, but it now began to spread to Bundaberg, Mackay, the Herbert and Johnstone Rivers, and Cairns. It is in these places to-day that almost the entire output is manufactured, the extreme southern districts making very little.

Sugar-growing continued to prosper, more land was brought under cultivation, and steam mills quickly superseded the antiquated cattle and horse-power erections.

In 1875, a disease termed "rust" broke out in the cane. This, combined with an excessive rainfall, fell like a thunderclap on farmers, and brought ruin to many of them. The financial institutions became alarmed, and refused to render further aid. Planters, however, were too energetic to let their estates go out of cultivation. The variety affected was known as the "Bourbon" cane; but it was noticed that small patches of "Rappoe" or "Rose Bamboo" were not touched. Those who survived the blow commenced the cultivation of this variety, and confidence was soon restored, though many plantations changed hands. During 1879 and 1880, a rush set in for Queensland sugar lands, and plenty of capital was made available. The production of sugar in 1870 and 1880 is given as follows:—1870, 2,854 tons; 1880, 15,681 tons.

During the next decade—1881 to 1890—the production of sugar in tons varied from 16,660 to 68,924; and from 1891 to 1900, 51,219 to 163,734. During the period under consideration, a large number of small mills were erected in most of the sugar-growing areas of the State, as well as many large factories. On the decline of prices owing to the stimulation of bounty-fed sugar in Europe, most of the small mills went under. During this time, also, a number of modern mills were erected under the Sugar Works Guarantee Acts, with capital found by the Queensland Government. These were known as "Central mills," and led to a further reduction in the small privately-owned mills. In 1901, there were some 60 sugar-mills in existence in Queensland; but from that date to the present, there has been a reduction from that number, caused by some of the more inefficient mills closing down.

The highest yield of sugar in any one year was 307,000 tons, in 1917.

In addition to the varieties introduced from other countries, a large number of seedlings, grown from the actual seed in the cane, have been raised by the Queensland Acclimatization Society and the Colonial Sugar Refining Company. As is usual in seedling work, very few of these were of commercial value, but a cane known as "Hambledon Queensland 426," raised in this way by the Colonial Sugar Company, is to-day comparatively extensively grown, and is of high sugar content.

CULTIVATION OF SUGAR CANE.

Soils.

The land in Queensland used for growing sugar is included in a long, narrow coastal belt, which is not continuous. Those parts which are suitable are separated from each other, often by considerable tracts of non-sugar producing country. The latter, owing to deficient rainfall or poorness of soil, are not utilized for cane. The sugar belt in Queensland is included between latitudes 16 degs. and 28 degs. South, but the bulk of the output is produced from Mackay North.

Cane soils vary considerably in character and composition. Cane as a plant demands an abundant supply of moisture, and so requires retentive soils. The open red porous soils of volcanic origin require frequent falls of rain to produce good crops of cane, and this, unfortunately, does not always take place in the rich soils of the Wongarra and Isis scrubs in the Bundaberg and Childers districts. The following classification of Queensland cane soils was made by Maxwell, formerly Director of Sugar Experiment Stations:—

District.	Soils.
Cairns	Partly shaley sterile soils, but in the main deep alluvial sandy loams, also rich red volcanic soils
Mackay ..	Shaley in parts, with better alluvial over the lower levels: mixed volcanic and rich siliceous alluvial
Bundaberg ..	Rich alluvial delta soils, interspersed with sterile soils and deep rich red volcanic soils

The bulk of the sugar soils can be stated to be from good to rich alluvial, such as river flats; and the deep-red volcanic soils of considerable depth. The nature of the country is generally designated "scrub" and "forest." The North Queensland scrubs are really jungles, carrying a thick growth of what is known as scrub timber, such as silky oak, bean, pender, kauri, milkwood, Johnstone River hardwood, interlaced with lawyer vine and other creeping plants, while the stinging tree is also conspicuous. Forest country usually consists of ironbark, bloodwood, Moreton Bay ash, bluegum, poplar-gum, and acacia.

The following are average analyses of a number of soils from each of the three sugar districts mentioned:—

District.	Total Plant Foods.				Available Plant Foods.*		
	Lime.	Potash	Phosphoric Acid.	Nitrogen.	Lime.	Potash.	Phosphoric Acid.
Cairns	·292	·310	·141	·122	·0654	·0132	·0010
Mackay ..	·829	·223	·165	·122	·1119	·0222	·0020
Bundaberg ..	·636	·144	·404	·120	·2755	·0083	·0018

* Aspartic acid analyses.

Weather Conditions.

Hot, humid conditions are the best for the sugar-cane plant, and, fortunately, these generally obtain during the period of the maximum growth of the crop in Queensland. The wet season is usually synonymous with the three hot summer months of January, February, and March.

Although the weather is hot and humid during this period, the higher temperatures experienced in the dryer belts of Australia are not common. A temperature of 100 degrees is rarely recorded. It is unusual for the thermometer to show much above 90 degrees, even in the middle of summer. Indeed, during times of heavy rain, the weather becomes comparatively cool, but as soon as the sun reappears, the atmosphere becomes steamy and the growth of the cane is vigorously promoted.

On the coast of Queensland, where sugar is grown, the greatest rainfalls occur where the mountain ranges come close into the coast. Where they are considerably distant, as at Bundaberg and Ayr, the lowest precipitations take place. Consequently, the greatest amount of rain falls at Babinda and Innisfail, where the lofty ranges of Bartle Frere and Bellenden Ker are not far from the seaboard.

The following table shows the average annual rainfall in each of the sugar districts:—

District.	Average Annual Rainfall in Inches and Hundredths.	District.	Average Annual Rainfall in Inches and Hundredths.
Mossman	82·91	Proserpine	76·96
Cairns	90·49	Mackay	68·52
Mulgrave	81·91	Bundaberg	44·40
Babinda	165·00	Gin Gin	37·71
Innisfail	149·20	Childers	42·07
Ingham	80·53	Maryborough	46·14
Halifax	89·17	Pialba	38·04
Ayr	44·48	Nambour	60·93
Bowen	40·60	Beenleigh	48·87

Humidity.

The mean relative humidity or percentage of moisture in the air is a most important factor in the growth of cane. The table hereunder gives the percentage of relative humidity in the principal coastal towns in the sugar districts at 9 a.m.:—

Place.	Percentage of Humidity.	Place.	Percentage of Humidity.
Bundaberg	69.0	Innisfail	80·0
Mackay	75.0	Cairns	70·2
Ayr	68·0		

Cultivation.

Land for cane growing requires plenty of tillage. Not less than four deep cross ploughings should be given, and then the soil should be well worked up into a fine tilth by harrowing and rolling. Sub-soiling to a depth of 20 inches or more on deep alluvial soils has been found to yield as much as 20 tons more cane per acre than from similar land cultivated in the ordinary way.

Two great factors in the preparation of our older cane lands are lime and green manure.

Owing to the long-continued growth of cane upon the same land, and also, in some instances, to the continued use of acid fertilizers, such as sulphate of ammonia and superphosphate, the bulk of our older cane soils in Queensland have become acid in reaction. This has been exhibited time after time in analyses of soils made by the agricultural chemist and by the Sugar Bureau. After ploughing out the stools it is, therefore, wise in most instances to apply lime, and it also has the advantage of increasing the purity of the juice of the succeeding cane crops. There are many other benefits to be obtained from a dressing of lime, which may be summarized as follows:—

(1) It acts on dormant mineral matter and renders available phosphoric acid and potash which would otherwise remain inert. (2) Acts on organic matter and converts part into nitrogen compounds available for the crop. (3) Enables the plant to make the greatest use of artificial fertilizers. (4) With moisture and warmth it favours the maintenance of abundant bacterial life, especially those forms which aid in nitrification. (5) It develops the activity of root bacteria in leguminous crops. In soils with an acid reaction, the fixation of nitrogen from the air is frequently at a standstill. (6) Improves the mechanical condition of the soil. Stiff clay soils are rendered more friable, less adhesive, and porosity is increased, so that its cultivation can be more easily undertaken.

Lime is usually applied to the soil in the following forms:—

(*a*) Burnt lime or lime oxide. (*b*) Air-slaked lime—*i.e.*, burnt lime that has been allowed to gradually slake in the air, and which ultimately becomes lime carbonate. (*c*) Water-slaked lime (lime hydrate). (*d*) Pulverized limestone (lime carbonate).

The growth of green manure crops is a form of rotation, and is not yet sufficiently practised in Queensland. It is also a means of restoring humus to old cane lands, and is a prime essential in the making of a fertile soil.

Humus benefits the soil—(1) By augmenting its water-holding capacity. (2) By increasing its warmth. (3) By bettering its texture and being a controlling factor in the determination of fine earth.

Humus in the soil is lowered by:—(1) The continued growth of crops. (2) Bare fallowing. (3) The continued use of commercial fertilizers.

The best possible crops to grow for green-manuring purposes are the legumes, such as cowpea, Mauritius bean, velvet and soya beans, lupins, vetches, &c. Among the advantages of a green crop are the following:—

(1) During growth the ground is shaded and moisture is conserved. (2) Erosion of fine earth is prevented during heavy rains. (3) Weed-killing is promoted. (4) The deep tap-roots of leguminous plants bring available plant-food from the subsoil to the surface soils. (5) The interposition of a crop, other than cane, that will act in minimizing fungoid diseases and insect attacks. If the habitat of parasites attacking the cane is removed for a time, it must result in their dying out or disappearance. (6) Crop rotation.

Nitrogen is the soil element that becomes the most quickly exhausted, as it is also the element that is the most expensive to purchase. The best time to plough-in green crops is at the time the seed in the pods is in a milky condition.

Selection of Plants.

This is a highly important matter to which too much attention cannot be paid.

Generally speaking, plant cane from ten to twelve months old, or first ratoon of the same age, should be taken. If the time of planting corresponds to that of harvesting, it is a good plan to cut as many top plants as possible from the best of the cane going to the mill. These are undoubtedly superior to the parts of the cane situate lower in the stick, although it is claimed that butts also make very good plants. The top plant, however, has the minimum of sugar, and contains nitrogenous bodies and salts which form food material for the plant during its early stages of growth. Top plants cannot always be procured, and it is then usual to cut up the whole stick for plants. Cane plants should be brought from colder to warmer climates, and from hillsides to lower levels, where it is invariably found to do well.

The best width of row has been found, from numerous experiments in Louisiana, Hawaii, and Queensland, to be 5 feet; though, in the case of a straight-growing cane, such as "D.1135," this could be reduced to 4 ft. 6 in. The drilling is best accomplished by means of a double mouldboard or drill plough. The plough should make a good wide drill about 9 to 10 inches deep in the loose soil. Where the cultivation has been deep and good, this will leave a few inches of soil for the plant to lie on. In a dry time, when planting by hand, there is usually a certain amount of moisture in this loose soil into which the plants can be pushed down, and so give them a much better opportunity to strike more rapidly. Three-eye plants are almost universally favoured, but the distance at which the plants are to be spaced apart in the row varies greatly in the different districts. At Bundaberg, the plants are often placed 12 to 18 inches apart, while on the Herbert River the planting is almost continuous. A good average distance for the spacing, and one found to give good results, is 6 inches. The plants are usually

put in about 9 inches deep when planting by hand, and covered with from 2 to 4 inches of soil—2 inches when conditions are very moist, and 4 inches when they are very dry. When planting by hand, the cane sets should be laid in the ground with the eyes at the sides, if possible. The cane-planting machine is now coming into great favour, and, while spacing cannot be carried out so evenly by its means, it puts the plant well down into the moist soil. It is a great labour-saver, and many types of machine are now upon the market.

Subsequent Cultivation.

As soon as the cane is up about 6 inches, the subsequent shallow cultivation should commence, and this, if properly done, is a factor which materially contributes to the after success of the crop.

Providing a number of deep ploughings have been given the ground before planting, the subsequent inter-row cultivation should be of a shallow nature, so that a thin layer of earth may be separated from the bulk of soil and laid as a mulch upon the surface.

Professor Hilgard ("Soils") remarks:—"The loose tilth of the surface, which is so conducive to the rapid absorption of the surface-water, is also, broadly speaking, the best means of reducing evaporation to the lowest possible point. . . . It is true that relatively coarse compound particles are incapable of withdrawing capillary moisture from the dense soil or subsoil underneath, just as a dry sponge is incapable of absorbing any moisture from a wet brick, while the dry brick will withdraw readily nearly all the water contained in the relatively large pores of the sponge. A layer of loose, dry, surface soil is therefore an excellent preventative of evaporation, and to moderate the access of excessive heat and dryness to the active roots."

While the use of a disc harrow may be permitted during the early stages of the crop, especially when some form of drill cleaner is pulled behind, its use should be prohibited directly it is found that the young cane roots—which subsequently begin to stretch out laterally—are being cut. There are now many devices in use in the cane-fields to obviate the labour of "chipping" or weeding the drills by hand. In some of these, a form of bent harrow is pulled behind the disc harrow or a two-row cultivator. This bent harrow sits in the drill, and if the weeds are taken when they are small they can nearly all be removed in this way. Others use a light form of triangular harrow in the drill, such as a strawberry cultivator. Special forms of implements for cleaning the interspaces and the cane drills at one operation are also to be procured. The cultivator should be run regularly through the cane, whether there are weeds or not, so as to insure the crop getting all the benefits from the cultivator, and to conserve moisture during dry times.

Disposal of Trash.

The trash is usually burned in Queensland, and there is a good deal to be said in favour of this method, provided humus is restored at intervals by the growth and ploughing under of a good green manure

crop. Trash often forms a harbor for vermin, pests, and fungous diseases of many kinds. It has been claimed that the increase in a ratoon crop, due to excellent cultivation, rendered possible by burning the trash, will more than compensate for the fertilizing ingredients lost in burning.

From the "stools" of cane, as they are called, a succeeding crop springs up. These require as careful after-cultivation as a plant crop, and it is usual, just after burning the trash, to well work the land with the plough.

It is believed that the best method of securing large yields of ratoon cane is to adopt the following procedure:—Immediately the trash is burnt, open up the middles of the rows to a depth of 9 inches with the swing plough; next subsoil these two furrows so that a further depth of 6 inches is thoroughly stirred. Next plough away from the cane rows on to the middles, and again follow with the subsoiler. By this means, the whole of the ground between the rows has been moved and stirred to a depth of 15 inches; and the benefit to the ratoons in thus breaking up the hard ground and letting in air and sunlight is difficult to over-estimate. Subsequent shallow cultivation with broad hoes should now be practised frequently, in the same manner as recommended for the plant crop.

The results obtained at the Experiment Station, due to this method of cultivating ratoons, are detailed in the table below:—

Crop.	Yield of Cane per Acre where the Ground between the Rows was Ploughed and Subsoiled.	Yield of Cane per Acre where the Ground between the Rows was only Ploughed to 8 Inches.
	English tons.	English tons.
First Ratoons	38·9	27·0
Second Ratoons	31·3	19·2
Third Ratoons	20·4	9·91

These experiments were not fertilized.

The question of manures has not been touched on, but cane is a plant which demands nitrogen, potash, and phosphorus. Hence, mixed fertilizers containing these three elements have universally been found to yield the best results. Mixtures containing from 7 to 12 per cent. of nitrogen in nitrate of soda and sulphate of ammonia, 7 to 10 per cent. of potash in sulphate of potash, and 5 to 9 per cent. of phosphoric acid in superphosphate are generally the most useful mixtures to apply. Sulphate of ammonia appears to be the best form of nitrogen to use in the face of the wet season. Nitrate of soda has been found specially advantageous in promoting a quick growth of cane when there is no danger of its being leached from the soil. It often shows its effect in a week or two, producing a rich dark-green colour in the foliage.

As a rule, considerably more benefit is got from the manuring of ratoons than from the manuring of plant cane, and this experience is common. This is strikingly shown in the following summary of experiments carried out at Mackay:—

Plant Crop.			First Ratoon Crop.		
Manures.	No Manures.	Difference.	Manures.	No Manures.	Difference.
50·7	47·4	3·3	42·4	31·7	10·7

Second Ratoon Crop.			Third Ratoon Crop.		
Manures.	No Manures.	Difference.	Manures.	No Manures.	Difference.
38·8	24·1	14·7	35·9	19·8	16·1

Sugar-cane removes varying amount of the vital elements from the soil. It is estimated, from analyses of the total cane plant (except roots) made in the Agricultural Laboratory, that the variety known as Clark's Seedling, sixteen months old, took from the soil 163 lbs. of potash, 83 lbs. of phosphoric acid, and 96 lbs. of nitrogen; while the variety known as Badila, of the same age, took out of the land 139 lbs. of potash, 44 lbs. phosphoric acid, and 107 lbs. of nitrogen.

Irrigation.

The climatic variations in Queensland from year to year are often so great that cane-growing is only certain in those districts possessing a high average rainfall. Districts with an average rainfall of 50 inches and under suffer exceedingly during dry spells, and irrigation would prove highly payable in such localities.

At the present time, the only cane-growing district that uses irrigation water to any extent is the Lower Burdekin, situated some 40 to 50 miles south of Townsville. On the north side of the Burdekin River, irrigation has been practised for a number of years, the plants used being the property of the farmers. Water is found at shallow depths, and is easily obtainable by sinking spearheads. On the south side of the river, the Government are installing a complete system, which will be available to growers of cane. Wells are being sunk, and the pumps will be electrically driven from a central power-house.

The cost of applying irrigation water on the Lower Burdekin is comparatively high, even though the most economical method is used. Consequently, there is a tendency to do as little of it as possible, and, in many instances, to postpone the application if rain appears probable. This frequently leads to the suffering of the crop should rain fail to fall and the irrigation has not been carried out.

Water is not applied scientifically to cane crops on the Lower Burdekin, so that the greatest efficiency is not secured. This, however, is largely due to the high cost of application. The method of irrigation is to run the water in shallow furrows between the cane drills, usually made with the disc harrow known as the Cotton King Cultivator. The water is generally conveyed by fluming to the main ditch running on the headland at right angles to the cane rows. The water is then admitted to the channels between the cane; but, as no attempt has been made to grade the land, a great deal of water is often wasted.

In Hawaii, the water is usually applied directly in the furrow or drill in which the cane plants are growing. The preparation of the land is more expensive, as it is laid out for irrigation according to the land contour, and the drills are cut into short sections so as to secure an even distribution. This method secures the largest economy of water. In the Queensland system, as practised at Ayr, it is not generally possible to evenly distribute the water over all the land, consequently some of the area goes short, while other parts obtain too much. This system, therefore, involves the greatest waste of water, but is the cheaper as far as actual application is concerned. This is, of course, a vital point in the cultivation of cane in Queensland, where the costs of labour are so high. It is usual to only make one or two, or at most three, applications of water on the Lower Burdekin, but these are large in volume, running up to 6 inches.

In Hawaii, on the contrary, the applications are smaller, but far more frequent, ranging from the equivalent of ½ inch of rainfall per week to 3 inches or more, as the crop makes greater demands upon the soil. These irrigations are carried on until the crop nearly reaches maturity; they are then stopped, so that the absence of water may have the effect of ripening the cane crop. With such a system, the application of manures can be carried out in the most satisfactory manner, and the combined use of water and fertilizers renders the cane crops of Hawaii the heaviest in the world, while the production of sugar per acre is also higher than elsewhere.

As irrigation for cane must eventually play a large part in sugar production in the drier cane areas of the State, the matter will ultimately have to be taken in hand, so that the water may be applied in the most economical way; and no doubt the Hawaiian system, which has proved so successful, will be tried. It is a noteworthy fact that much larger crops can be grown with irrigation properly applied in dry areas than on lands where the rainfall is plentiful.

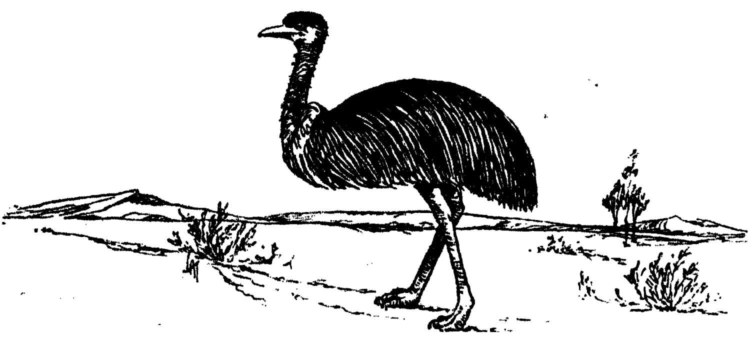
Conclusion.

With the improved outlook due to the fairer price now to be paid for sugar by the Federal Government, a larger production of sugar may be hoped for. The consumption is rapidly rising, and it should become the duty of sugar-growers and manufacturers to supply enough sugar for Australian requirements, and so prevent importation from countries using black labour at high prices.

The writer thinks he cannot do better than conclude his paper with an extract taken from the Report of the First Federal Commission on the Sugar Industry:—

"The problem of the sugar industry to-day is not, save in subordinate respects, a problem of industry, of wealth, or of production; it is primarily and essentially a problem of settlement and defence. No nation can afford to regard lightly the development of its industries, the progress of its wealth, or the economic efficiency of its productive machinery. But, important as these things undoubtedly are, they rank, as regards the sugar industry, on an inferior plane. The Commonwealth to-day is brought face to face with one of the gravest problems that has ever taxed the ingenuity of statesmanship—that of the settlement of tropical and semi-tropical areas by a white population living under standard conditions of life. And intimately associated with this problem is the question of national defence.

If the ideal of a White Australia is to become an enduring actuality, some means must be discovered of establishing industries within the tropical regions. So long as these regions are unoccupied, they are an invitation to invasion, as well as a source of strategic weakness. Granted so much, it follows that the supreme justification for the protection of the sugar industry is the part that the industry has contributed, and will, as we hope, continue to contribute to the problems of the settlement and defence of the northern portion of the Australian continent. The recognition of the nature of this supreme justification is the first condition of a sound public policy in relation to the sugar industry. Relatively to it, all other issues are of minor importance."



Bovine Tuberculosis and its Repression

[The following statement is a summary of a lecture given at the Royal Society of New South Wales recently by Professor Douglas Stewart, of the Veterinary School, University of Sydney. Some time ago the Institute appointed Special Committees in each State to inquire into the prevalence of tuberculosis in live stock, and the different reports are now being prepared with a view to their publication as a bulletin. Professor Douglas Stewart was Chairman of the New South Wales Committee. Apart from the monetary loss to the Commonwealth from this disease, there is the more important consideration of conserving public health. The danger to the community from the existing methods of supervision followed in New South Wales is readily apparent. In one or two of the other States, where there is practically no expert supervision, the danger is intensified.]

After explaining, with the aid of a number of lantern slides, the actual cause and the morbid conditions produced by the disease, Professor Stewart referred to the different pathogenic effects of the three recognised types of tubercle bacillus, and described the manner in which the disease is disseminated. Infection occurs, as a rule, during extra-uterine life, and in the vast majority of cases it is acquired through the medium of contaminated inhaled air or ingested food. Inhalation is the more certain method of infection, and the danger of keeping a tuberculous animal on the farm, even though it is not being milked, was stressed. In food ingestion, raw milk plays an important part. Not only is the milk from cows with evident tuberculous symptoms dangerous, but milk from apparently healthy tuberculous cows may contain tubercle bacilli derived from deep-seated udder lesions, or contaminated discharges from the uterus or bowels soiling the hind-quarters. Further, the milk of perfectly healthy cows may become contaminated by dust containing infective tubercular matter voided by another member of the herd. Apart from bacteriological findings, there is ample evidence of the infectivity of raw milk from an infected herd in the prevalence of tuberculosis in pigs fed on it and the marked decline in the incidence of the disease among these animals when fed on milk that had been pasteurized.

Professor Stewart pointed out that, apart from the necessity of controlling bovine tuberculosis to prevent the heavy monetary losses it is responsible for, and which have been estimated by a Special Committee appointed by the Federal Institute of Science and Industry to amount to about £250,000 per annum in New South Wales alone, the repression of the disease is indispensable to any complete scheme adopted for the protection of public health. While the great majority of fatal cases of tuberculosis in man are caused by tubercle bacilli of the human type, there is now abundant evidence that the bovine type of tubercle bacillus is responsible for much tubercular infection of human beings, commonest during infancy, particularly of neck glands and alimentary tract. Official returns from different countries were compared, showing the striking agreement between the prevalence of tuberculosis in dairy cows and the existence of neck and abdominal tuberculosis in children.

After describing the symptoms of the disease in cattle, and discussing the various diagnostic procedures, Professor Stewart outlined the different measures taken in other countries to repress animal tuberculosis, and compared those which obtain in this State. There are no less than eight legislative measures (six State and two Federal) that contain provisions that directly or indirectly aid in the control of animal tuberculosis, administered by four separate departments, all of which have special staffs. The provisions of the Federal Quarantine Act prevent the introduction of tuberculous animals from oversea; those of the Stock Act from other States. The object of the provisions of the Cattle Slaughtering and Diseased Animals and Meat Act, the Meat Industry Act, and the Federal Commerce Act is the protection of public health by preventing the consumption of tuberculous meat, and the best guarantee that can be offered the community of the protection conferred in this connexion is the employment of a sufficient number of inspectors of the highest training. Yet we find that on the staff of the Metropolitan Meat Board there are but two qualified veterinary officers, who are almost entirely engaged at the Homebush Abattoirs; while the Commonwealth Service has a like number supervising the inspection of exported meat at different centres. The smallness of these staffs, when compared with those employed by other countries, clearly indicates that the system of inspection as carried out by both the Federal and State Governments is capable of considerable improvement. The inspection of meat is essential for the protection of public health by providing for the safe disposal of affected parts and organs. To be effective, the standard of training for the staff must be high. Efficient inspection is also desirable from the stock-owners' point of view, as it prevents unnecessary loss by the destruction of wholesome meat in localized affections. It is not a simple matter to distinguish in every case meat that is dangerous from that which is wholesome, and the inspector must be guided by his pathological knowledge. The more extensive the technical knowledge of the inspector is, the less liability is there of erroneous judgment. An efficient system is also necessary to facilitate the tracing of infected herds and for the collection of reliable statistics to determine the incidence of the disease from time to time, in order to judge as to progress being made.

"Manifest," or evident tuberculosis, is dealt with under the provisions of the Stock Diseases (Tick) Act by the Department of Agriculture (Stock Branch), on the staff of which are six veterinary officers. The Stock Branch, however, does not carry out the systematic inspection of herds as a routine procedure, but deals with individual cases reported to or detected by its inspectors.

The local authorities are charged with the administration of the Dairies Supervision Act, under the direction and supervision of the Board of Health. The provisions of the Act have now been extended to practically the whole of the populated portion of the State, and within a municipality the local authority is the council thereof; but outside municipal areas, the local authority is the Police Magistrate, or senior police officer. The qualifications of the officer inspecting dairy cattle for the local authority is not specified, and, owing to the many difficulties that arose in connexion with the administration of the Act, the Board of Health created a special staff of dairy inspectors to

supervise the work carried out by the local authorities. For many years after the Act came into operation, all the members of this special staff were qualified veterinarians, and the employment of officers of the highest possible standard was undoubtedly sound, as it guaranteed the efficacy of the service to the general public, and offered stock-owners a desirable protection against their property being wrongly confiscated. As the result, a considerable amount of progress was made in the control of bovine tuberculosis, which, unfortunately, has not been maintained. Not only has no advancement been made in the methods of controlling the disease, but there are signs of distinct retrogression, for at the present time there is no qualified veterinarian on the staff of the Department of Public Health, and the inspection of dairies is carried out solely by lay inspectors. Moreover, the existing staff of about fourteen inspectors is quite insufficient to supervise the health of over 500,000 milking cows belonging to more than 20,000 dairies scattered over a huge territory. In fact, many individual herds are not seen once a year. Further, the Dairies Supervision Act is in need of considerable amendment to become an efficient measure for suppression of animal diseases in dairy herds, and recommendations made by a special Committee over eight years ago have not yet been given effect to, although it is understood that the matter received consideration.

Tuberculosis is but one of many diseases (anthrax, contagious abortion, tick pest, &c.) that cause grave losses to the revenue of the State, amounting to over a million pounds sterling each year; and, in the opinion of Professor Stewart, the time has arrived for the consideration of a more comprehensive scheme of control than now exists to check this leakage, and to improve our flocks and herds. With this object in view, he strongly urges that consideration be given the desirability of consolidating the various Acts dealing with animal diseases, and effecting requisite amendment; amalgamating the inspectorate now working under three different State Departments to obviate overlapping, effect economy, and improve the service; creating a "Live Stock Board," on which the industries vitally concerned might with advantage have representation; employment of additional inspectors with full veterinary qualifications; extension of advisory services to stock-owners, with appointment of resident veterinary officers to the more important districts; providing for scientific investigation to discover more effective and economic methods of controlling animal diseases.

In conclusion, stock-owners were appealed to for whole-hearted co-operation, and strongly advised to immediately destroy animals affected with serious infectious diseases, and to isolate all suspects until authoritative opinion is obtained; to exercise greater care in the selection of breeding cattle; to improve their methods of animal husbandry, particularly in regard to rearing and feeding, so as to increase the animals' resistance against disease; and to improve the sanitary condition of sheds, cattle-yards, calf-pens, &c. The necessity of disinfecting railway trucks after carrying live stock was also referred to.

A Chalcid Parasite of Diptera.

By H. M. NICHOLLS, Government Microbiologist, Tasmania.

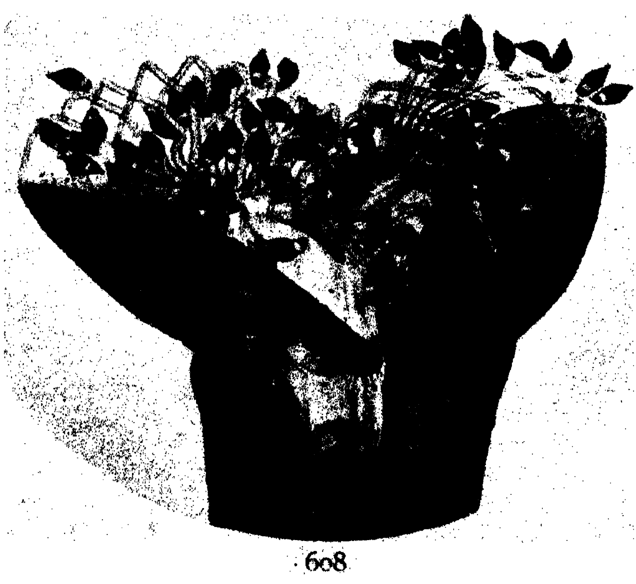
Last summer, the writer collected several specimens of a very curious parasite of March flies and other dipterous insects. He first found it about fifteen years ago on March flies, blowflies, and a large fly belonging to the *Dexiidæ*, in the Huon district, but never saw it again until quite recently. It is so minute that it is barely visible to the unaided eye, and is ovate in shape and of a dark-brown colour. The body is composed of thirteen strongly chitinised segments, and the head is provided with a pair of very strong hooked jaws, with which the parasite attaches itself to the pseudo-tracheal tubes of its host. When removed from the host it can crawl about quite actively with a caterpillar-like motion, and seems at home when placed in water.

Its nature remained a mystery for many years, as the writer had no opportunities of breeding it to ascertain its life-history, until light was thrown on its affinities by the publication of an account of the discovery of a somewhat similar creature in America, which was found as a hyper-parasite of the larvæ of *Limnerium validum* in the caterpillars of the fall web-worm, *Hyphantria textor*. The American specimen was found to be a stage in the development of a chalcid belonging to the genus *Perilampus*. Dr. W. M. Wheeler, it appears, had previously discovered a somewhat similar stage in the life-history of another chalcid, *Orasema viridis*, and had proposed the name "planidium" for it, to indicate the motile and wandering habits that at this stage it possesses.

The specimens found in Tasmania differ somewhat in anatomical details from the descriptions of the American varieties, but the general plan of construction is exactly the same, and there is no doubt that this very curious little creature is the planidium stage of one of our native chalcids. In its habits it differs from its American congeners, as it appears to be entirely an ecto-parasite, spending the whole of its larval existence attached to the proboscis of its host. Specimens are occasionally found which have fed until they have swelled up to an extent which separates the chitinous plates of the body and causes the parasite to assume the appearance of a small globe of a whitish colour, and a somewhat similar appearance is shown in the drawings of the planidium stage of *Perilampus*.

This parasite is sometimes found in great numbers, especially on species of *Tabanus*. One *Tabanus* proboscis in the possession of the writer has no less than 74 adhering to it. When attacked to this extent the flies seem to be rendered incapable of feeding properly, and become weak and sluggish. It may be mentioned that these little creatures hold on like bull-dogs, and it is generally impossible to remove them without tearing away some portion of the proboscis with them. Some of the mounted specimens in the writer's collection still have a mouthful of pseudo-tracheal tubes in their jaws. It is probable that this parasite is really very common, but it is so minute, and spends its larval existence in such an unusual situation, that it is not likely to ever come

CHALCID PARASITES ON PROBOSCIS OF TABANUS. (Magnified.)



under the notice of any one but the specialist. The photomicrographs of the parasites on the proboscis of *Tabanus* will give a good idea of the extent to which these flies are sometimes attacked. An account of them was published by the writer a good many years ago in the journal of the Tasmanian Field Naturalists' Club, but, as nothing was then known as to the nature or affinities of the creatures, they did not excite any curiosity. It would be very interesting to know if they occur on the mainland of Australia as well as in Tasmania.

CHALCID PARASITES ON PROBOSCIS OF DEXID. (Magnified.)

Dyes and the Safety of the Nation.*

By Dr. HERBERT LEVINSTEIN.

Danger of British Delay.

It is not generally known that after the battle of the Marne there was a munitions crisis in Germany. The stock of shells, the huge accumulation of high explosives with which the German General Staff had calculated to overwhelm the French, had petered out before the gates of Paris. Certainly the Allies were in no better case, for they also were without stocks of shells or high explosives. As a consequence, both sides settled down into more or less permanent entrenchments.

Some day the essayist of the period will speculate on what would have been the history of Europe during the coming 100 years had either of the belligerents in the great war possessed an adequate reserve of high explosive shells after the Marne. For this had been planned by the German General Staff to be a high explosive war, wherein the Germans would overwhelm their enemy by using more heavy guns, firing a greater weight of shells filled with vaster quantities of high explosives than they (not knowing the British infantryman) calculated that modern civilized troops could stand.

To the German General Staff the vital question, therefore, after the Marne, was how to re-organize the German production of shells and high explosives so as to re-establish their supremacy in these agents of destruction.

The I.G.

To this end, as we know from General Ludendorff's *Memoirs*, the Chief of the German General Staff summoned two men to his assistance, Krupp von Bohlen and Dr. Duisberg. Everybody has heard of Krupps; Dr. Duisberg, one of the makers of modern Germany, is perhaps not so well known. He is the head of the I.G.—the great Interessen Gemeinschaft—the great combine of the German aniline dye manufacturers.

With this meeting commenced that close connexion between the German General Staff and the German I.G. which was, indeed, the agency by which Germany was, in spite of our blockade, able to keep the field from the battle of the Marne until November, 1918. That may appear a difficult point to believe, for, on the face of it, no occupation could be more harmless than the furnishing of dyes. It is easy to demonstrate its accuracy.

Most of the German dyestuffs plants were not mobilized at the outbreak of war. Why not? Because the German General Staff did not go to war until the stock of explosives secretly accumulated over a long period appeared to be adequate to bring about the swift defeat of the Allies. It was, at first, considered preferable for the dye factories of the I.G. to continue producing stocks of dyes with a view to re-establishing, at the conclusion of the campaign, that dominance over the textile trades of the world which the German Government considered to be the main function of the I.G.

* From *The Times*, London.

Thus, most of their plants were not used at the very commencement of war as arsenals. It is interesting to note this, for they were a more dangerous and subtle thing. They were potential arsenals engaged between the commencement of the war and the Marne on their lawful avocations; from the Marne to the conclusion of the war they were an indispensable part of the German war machine, enabling the war to be prolonged for three whole years. Immediately after the Armistice they again became peaceful industrial concerns, and no one more loudly proclaimed their peaceful character than Dr. Duisberg himself. But the views expressed by Dr. Duisberg subsequent to the German defeat were very different from the answer he gave to the General Staff at the interview referred to by Ludendorff.

High Explosives.

The Leverkusen Works were erected purely for the manufacture of aniline dyes and pharmaceutical products. As Dr. Duisberg told us himself, they were at first considered far too valuable by the German Government for them to be risked in the manufacture of explosives; yet, within six weeks of the interview, they commenced to deliver T.N.T. at the rate of many millions of pounds per month. Truly a satisfactory response from a perfectly peaceful works. I wonder what our High Explosives Department at Storey's Gate would have given at that stage of the war to possess a factory which could, owing to its well-standardized plant, within six weeks produce sufficient T.N.T. to fill millions of shells a week without calling upon their resources of oleum and nitric acid.

The production of picric acid (lyddite) was just as simple for Leverkusen, for their dye-making plants provided them with the raw materials. What happened at Leverkusen occurred at the other great factories of the I.G. in similar measure, and, as the Hindenburg programme became more developed, and as the demands of the General Staff became greater, vast quantities of explosives were produced by the factories of the I.G.

The Leverkusen Works of the Bayer Company form only a portion of the I.G. factories. There are others equally important at Dormagen, Hochst, Ludwigshafen, and Oppau, all situated on the Rhine, within the occupied territory, and smaller factories, for example, Weiler-ter Meer and Kalle and Company, who, as the war went on, produced enormous quantities of explosives.

We, too, as the war developed, produced enormous quantities of high explosives, but not at the same speed, for great factories had to be erected for the manufacture of oleum and nitric acid, and our explosive plants, contrary to the German plants, have, generally speaking, only a war value.

Chemical Welfare.

But this meeting between the head of the I.G. and the Chief of the German General Staff has another significance, and a more sinister one. The war, from the German point of view, as stated above, commenced as a high explosive war. With the failure of their first surprise break through, the German General Staff began to look for some other

means of creating a surprise. As we know now, they decided to introduce chemistry into war, relying on the fact that their dyestuff monopoly would enable them to have a great advantage over the Allies in the production of toxic substances. Their first attack with chlorine was in April, 1915. Had the Germans realized at the time the success of their opening attack, it is possible that the results would have been disastrous to the Allies.

A defence was very soon improvised by us against chlorine. Subsequently, phosgene, of which the German dye-makers produced large quantities in peace time for the purpose of making dyes, was introduced, and afterwards a variety of organic substances was employed.

With one insignificant exception, the whole of the chemical warfare products used by Germany in the struggle were made by the I.G. At the same time, their research organization was largely devoted to the discovery of new toxic substances suitable for use in war.

How close was the connexion between the General Staff and the I.G. is shown not only by the interview referred to by Ludendorff, but by the fact that whenever the German military authorities wished to introduce a new gas, a conference was held in Berlin with the representatives of the I.G. No other firms were represented. The substances used were numerous. The manufacture was complicated, sometimes dangerous. They were used in vast quantities, and, therefore, very large manufacturing resources were required. Yet no other firm had a hand in their production. The technical methods adopted were those suggested by the I.G., Berlin. The I.G. suggested methods which could be carried out in their dyestuff plants.

Dangerous Delays.

In our own country, when a new gas had to be made in the late war, plant had, in nearly every case, to be specially erected for the purpose. This involved great delay before the product could be used in the field, and the plants are now nearly valueless either for peace or for war.

In war it is of the utmost importance that the inevitable lag between the discovery of a substance suitable for use in the field and its production on a sufficiently large scale should be as short as possible. There are usually several ways in which the same substance can be prepared. In war that process will be selected which will produce the substance in the desired quantity with the least possible delay; for instance, in plant already existing. For this reason most of the poison products used by the Germans were not made in one factory. Certain operations were carried out in another plant. Thus, in the case of mustard gas, the intermediate product was prepared at Ludwigshafen, the finishing steps involving the production of mustard gas at Leverkusen. The reason for this was that at Ludwigshafen there was already in existence plant erected for making dyes which was suitable for the manufacture of thiodiglycol. This plant was extended at Ludwigshafen, and is now available for the increased production of dyes.

The military value of chemical warfare is little understood owing to the secrecy in which the work has been done. In the popular mind it is associated with a feeling of peculiar revulsion, and its true significance from the military point of view has been obscured by the

horrors attending its employment against unprotected troops. Actually, gas warfare developed from the crude, dastardly attack at Ypres on unprotected troops into a distinct branch of warfare which, however reprehensible, became of rapidly increasing importance. Gas warfare soon resolved itself into a contest between gas defence (*e.g.*, gas mask) and the discovery of new gases which would penetrate the opposing gas defences.

Military Importance.

The real military importance of chemical warfare lies in the opportunity it gives to a commander of effecting a surprise, which is the essence of war. By the discovery of a new substance capable of penetrating the enemy's gas defences, and its use on a sufficiently wide front without previous notice, chemical warfare offers, under modern conditions, an incomparable opportunity for effecting a surprise.

On several occasions, particularly with mustard gas, the Germans effected a complete surprise and achieved important tactical results. If they failed in bringing about a decision favorable to the German arms, they only narrowly failed, perhaps, only because they were used for the first time in inadequate quantities and on too narrow a front. In the next war chemical warfare will play a decisive part; that appears to be certain. It will probably not come before the enemy feels sure that he can produce a surprise on a sufficiently large scale to bring about a quick decision. It is thus highly improbable that he will rely on the same substances that were used in the late war. It is, on the other hand, highly probable that he will use new substances, which can be made in plant used in peace time for the manufacture of aniline dyestuffs.

Conclusions.

It will be seen that the German dyestuffs organization is of decisive importance in chemical warfare for three reasons:—

(1) That it is capable of producing practically any organic substance.

(2) That it is very large and can, therefore, produce the required substance quickly in quantity sufficient to satisfy military requirements.

(3) That it possesses not only the plant, but also the skilled *personnel*, the trained research staff, and the technical experience so indispensable for the manufacture of complicated substances.

These facts were clear to the German General Staff when they sent not only for Krupp von Bohlen, but also for Dr. Duisberg. It is well that they should be clear also to us. The factories are not arsenals, but potential arsenals adding to the power of their country in peace and strengthening their country in war proportionately to their growth in peace.

The organization of the German aniline dye industry is entirely admirable. The sales, research, and works organization is of a high

standard of technical excellence. The industry has behind it the power of the German Government, who used it to carry out their policy of peaceful penetration before the war and to secure a hold upon the textile industry of all other countries.

The greater the production of dyes in peace, the greater the strength of Germany in war. What are the inevitable conclusions? The greater our production of dyestuffs, the less have we to fear from a surprise attack by the Germans. The possession of a counter to this weapon of the I.G. is the surest guarantee of peace. Deliberately to leave to the Germans the monopoly in the rapid production of toxic gases on a large scale is a thing which no responsible statesman will contemplate with equanimity.

I do not, in the least, advocate the continuance of gas warfare. Those who have been concerned in the manufacture of the most dangerous of these products are not advocates of their retention as a means of warfare. I do not desire to build plants for the purpose of making toxic gases, wishing, as I do, with my whole heart for the abolition of this mode of warfare. No person can contemplate without horror the thought of being again engaged in a struggle such as that from which we have barely emerged with safety.

President Wilson's View.

No man has shown himself so desirous of abolishing war as President Wilson, the great protagonist of the League of Nations, yet this is what he said: "The close relation to the manufacture of dyestuffs on the one hand and explosives and poison gases on the other hand, moreover, has given the aniline dye industry exceptional significance and value. Although the United States will gladly and unhesitatingly join in the programme of any national disarmament, it will nevertheless be a policy of obvious prudence to make certain of the successful maintenance of many strong and well-equipped chemical plants."

If President Wilson is convinced that, in spite of the Treaty of Versailles, and the signing of the Covenant of the League of Nations, a strong dye industry is required for the security of the United States, we may justly consider that our own island is not safe if we have in peace time no factories in this country comparable with those of the I.G.

The length of this article precludes me from referring at length to the Haber process for making ammonia, which, combined with the Ostwald process for producing nitric acid from ammonia, enabled the Germans to carry out the manufacture of high explosives in spite of our blockade; but for the development of this process by the I.G. the Germans would have been unable to continue the war after 1916.

The manufacture of ammonia by this process is being taken up in this country by a powerful and able concern greatly to our national advantage, but the research organization which produced the Haber process which we are now adopting was that of the I.G., and unless research organization of similar character is encouraged in this country we shall continue to be following instead of leading the Germans in the discovery of chemical inventions of industrial and military importance.

First Pan-Pacific Scientific Conference, Honolulu.

By H. C. RICHARDS, D.Sc., Professor of Geology and Mineralogy, University of Queensland.

The First Pan-Pacific Scientific Conference, which was held in Honolulu from 2nd August to 20th August, 1920, dealt with so many scientific problems of interest to Australia that it is highly desirable that people in this country, and scientists in particular, should be acquainted with the nature of the Conference, the matters which were discussed, the proposals for the permanent establishment of the Conference, and the suggested means and methods of carrying out the proposed research.

The underlying idea of the Conference was to bring together in some central position scientific workers representative of the different sciences and the different countries bordering on or contained within the Pacific Ocean region, with a view to considering what scientific problems await investigation, what their bearing and importance may be, and the best means of achieving their solution.

The general preliminary arrangements were made by a committee of the members of the Pan-Pacific Union resident in the Hawaiian Territory, while the chairman of the Conference was H. E. Gregory, Ph.D., Professor of Geology in the University of Yale and Director of the Bernice Pauahi Museum, Honolulu, and the vice-chairman and secretary, Arthur L. Dean, Ph.D., President of the University of Hawaii.

Invitations to attend the Conference were extended to well-known scientific workers and to the various scientific institutions bordering on the Pacific Ocean.

Approximately, 110 delegates attended, and included representatives of Australia, New Zealand, Philippine Islands, Japan, China, Hawaiian Islands, Canada, and the United States of America; representatives from the British and French Possessions in the Pacific were unable to attend.

An analysis on the basis of the country of the delegates attending shows that the great majority of members was composed of delegates from the Hawaiian Territory and the United States of America:—

Hawaiian Territory	44	delegates
United States of America	43	,,
Australia	6	,,
Philippine Islands	5	,,
Japan	4	,,
New Zealand	3	,,
Canada	2	,,
South Sea Islands	2	,,
Great Britain	1	,,
China	1	,,
	111	,,

An analysis of the delegates on the basis of science represented results as follows:—

Zoologists	21	(including 3 Hawaiian delegates)
Anthropologists and Ethnologists	17	„ 6 „ „
Botanists	17	„ 10 „ „
Geologists and Vulcanologists	16	„ 2 „ „
Entomologists ..	14	„ 12 „ „
Oceanographers and Geodetic Engineers ..	8	„ 3 „ „
Seismologists	7	„ 1 „ „
Agriculturists	5	„ 3 „ „
Economic Chemists ..	3	„ 2 „ „
Meteorologists	2	„ 1 „ „
Astronomers	1	„ 1 „ „
	111	

It will be noted that the Botanists and Entomologists were very largely local people who are engaged by the Hawaiian Sugar Planters' Association and kindred bodies.

The Australian delegation was as follows:—

F. Wood-Jones, M.D., Professor of Anatomy, University of Adelaide.

H. C. Richards, D.Sc., Professor of Geology, University of Queensland.

Leo. A. Cotton, D.Sc., Assistant Professor of Geology, University of Sydney.

Charles Hedley, F.L.S., Australian Museum, Sydney.

E. C. Andrews, B.A., Government Geologist, Mines Department, Sydney.

C. A. Sussmilch, F.G.S., Director Technical School, Newcastle, N.S.W.

The Executive Committee of the Conference, which was composed of the Chairman and Secretary, together with the leaders of the various sections, was as follows:—

H. E. Gregory, Ph.D., Professor of Geology, University of Yale (President).

A. L. Dean, Ph.D., President University of Hawaii (Secretary).

Clark Wissler, A.M., Ph.D., American Museum Natural History, New York.

Charles Chilton, M.A., D.Sc., Professor of Biology, Canterbury College, New Zealand.

W. E. Safford, Ph.D., Economic Botanist, United States Department of Agriculture.

F. Muir, Entomologist, Sugar Planters' Association, Hawaii.

W. M. Bowie, M.A., D.Sc., United States Coast and Geodetic Survey.

T. W. Vaughan, M.A., Ph.D., United States Geological Survey.

F. Omori, D.Sc., Professor of Seismology, Tokio, Japan.

FIRST PAN-PACIFIC SCIENTIFIC CONFERENCE.

The Conference was held on lines somewhat similar to those adopted at the meetings of the Australian Association for the Advancement of Science, and was held in the Throne Room of the Capitol Building, Honolulu.

There was a general session each forenoon, and in the afternoons the several sections met. There were sections in—

Anthropology—Chairman, Clark Wissler; secretary, J. F. G. Stokes.

Biology—Chairman, Charles Chilton; secretary, C. N. Edmundson.

Botany—Chairman, W. E. Safford; secretary, C. A. Forbes.

Entomology—Chairman, F. Muir; secretary, D. T. Fullaway.

Geography—Chairman, W. M. Bowie; secretary, G. W. Littlehales.

Geology—Chairman, T. W. Vaughan; secretary, H. S. Palmer.

Seismology and Vulcanology—Chairman, F. Omori; secretary, T. A. Jaggar.

At the general sessions the following matters were discussed:—

Ocean Currents and their significance.
Origin of Hawaiian Fauna and Flora.
Race Relations in the Pacific.
Volcanism in the Pacific.
Seismology in the Pacific.
Framework of the Pacific.
Mapping the Pacific.
Training of Scientists for Pacific Work.
Means and Methods of Co-operation.
Programme of Research.

In the Section Meetings papers were read by members and subsequestly discussed, also resolutions and programmes of research for adoption by the General Conference were prepared.

The results of the Conference demonstrated the high value of meetings for the discussion of problems common to all countries whose interests lie wholly or in part within the Pacific area, also that the problems relating to the welfare of Pacific peoples are too large and too complex to be solved satisfactorily except by sympathetic co-operation of individual organizations and Governmental agencies.

It was resolved, therefore, that the Governor of Hawaii should be asked to take such steps as would result in the establishment of a permanent organization vouched for and supported by the various Pacific countries and designed for the advancement of the common interests of the Pacific, including scientific research.

It is hoped that future conferences will be held every three years at such places as Wellington, Sydney, Suva, Manilla, Tokyo, San Francisco, Vancouver, and Honolulu.

It is not unlikely that Wellington will be selected as the next meeting place.

A large number of resolutions were adopted, but the full list cannot be published here, and it will not be until the Proceedings of the Conference are issued some months hence that they will be readily available.

The resolutions of more particular interest to Australia have been selected, and appear below.

In connexion with the promotion of Education, the Conference resolved—

1. That in order that young men may enter upon scientific careers without sacrificing all hope of reasonable financial returns, the compensation for instruction and for research in science be increased so that all can at least be assured of a comfortable living for themselves and their families, and that men of exceptional attainments may receive financial rewards which shall approximate those which their powers could command if directed to commercial ends.

2. That persistent efforts be made to inform the public of the progress of science, and of its bearing upon the practical affairs of life.

3. That, to enlarge the experience and vision of the instructors in the various colleges and universities of the Pacific countries, making them thereby more competent and inspiring teachers, the exchange of teachers between institutions in different countries to be encouraged and made possible.

4. That a clearing house of information relative to opportunities for scientific study and research in the Pacific area be established.

5. That arrangements be perfected between the universities and other research institutions whereby properly qualified students may move from institution to institution, carrying on their work at the place or places where the best facilities are available for the special kind of work upon which each may be engaged.

6. That a considerable number of fellowships be provided, with adequate stipends, which shall be looked upon as compensation for the faithful performance of scientific work, and that especially able work by young investigators be rewarded by substantial prizes.

7. That to stimulate interest in the Pacific, and inculcate a knowledge of its importance and unity, text books should be prepared in which proper emphasis will be placed upon the Pacific area, its physical features, peoples, fauna, flora, resources, and trade, and that the schools in the Pacific countries be encouraged to give instruction which will stimulate the interest and enthusiasm of young students in the objects and phenomena of their environment.

In connexion with Anthropology, it was decided to recommend—

That the most prompt and efficient steps be taken to record the data necessary to the understanding of man's development in the Pacific area; also

The creation of centres for the study of anthropology and original research therein, such centres to be developed by the expansion of university departments or the alliance of universities with other research institutions, with the result that these schools of anthropology shall combine all the essential features of a museum, a research staff, and a graduate school. And, further, because of the peculiar conditions under which anthropological data must be gathered, necessitating both intensive field work in circumscribed areas extending over several years, and intensive synthetic

work by men who are masters in many fields, thus requiring a number of men through a period of years, we therefore recommend the establishment of research fellowships for linguistic research. such endowments being provided that these fellowships will attract the best men available, and provide for uninterrupted work during an adequate number of years.

In connexion with Biological Science, it was resolved, amongst other things—

1. That the first Pan-Pacific Scientific Conference recommends that the Governments of the several nations bordering on the Pacific Ocean co-operate, through their several agencies concerned, in surveying and charting the sea, toward the collection, compilation, and publication of data relating to the topography of the bottom, and the temperatures, salinities, acidities, currents, and other physical and chemical properties of the waters of this ocean, fundamental to biological research, and the improvements and conservation of the fisheries.

2. That the Conference recommends that a comprehensive systematic biological survey of the Pacific Ocean and its contained islands be prepared, with special reference to the economic fisheries problems, and that the investigation be carried on in so far as possible through existing agencies, such agencies to be provided with the additional apparatus and facilities necessary, the investigation to be carried on under such co-operation as will prevent duplication of effort.

In connexion with Geography, it was resolved that—

A general hydrographic survey of the Continental shelves extending off-shore to the 1,000-fathom curve, and of the island platforms should be executed, in order to supply basic data essential to all research work involved in the general scientific exploration of the Pacific Ocean; also

A systematic oceanographic investigation of the Pacific should be undertaken as soon as possible. The plan adopted should be designed to complete the survey of the most critical areas at an early date, and eventually the whole Pacific region.

In connexion with Geology, it was resolved, amongst other things—

That the following maps of the Pacific region on the international scale of 1 : 1,000,000 be prepared as expeditiously as possible:—

(*a*) A base map, showing by contours or hachures as many topographic features as practicable;

(*b*) A map showing geographical formations or groups of geological formations;

(*c*) A map showing mineral resources.

Also—

(*a*) That the configuration of the bottom of the Pacific Ocean be determined with adequate accuracy;

(*b*) That charts of the littoral and sub-littoral zones be made in all practicable detail, for example, wherever possible these charts should be on scales ranging between 1 : 10,000 and 1 : 40,000.

And—

That steps be taken to advise in the planning of research to correlate the efforts of the different workers, and to promote in such ways as may be proper a uniform mode of publication of results.

In connexion with Seismology and Volcanology, it was recommended—

The continuance of the present volcano observatories, and the establishment of new permanent volcano observatories in lands about the Pacific; and recommends that such a station for maintenance and publication of continuous observations should be placed on one or more active volcanoes in each important volcanic district.

That precise levelling and triangulation be carried on at definite time intervals, in selected seismic and volcanic districts, in order to ascertain precursory and other changes in underground stress accompanying great seismic and volcanic disturbances.

That each Pacific country publish statistical lists of local eruptions, earthquakes, tidal waves, and other related phenomena; and issue catalogues of active, dormant, and extinct volcanoes, and of local seismic features.

The establishment of a central bureau for dissemination of scientific knowledge among the volcano and earthquake stations of the Pacific.

The Conference was undoubtedly a great success in bringing together representative scientists from around the Pacific, and much mutual benefit resulted.

The resolutions serve to show the very wide range of problems awaiting investigation, and it is obvious that Australia is highly interested and concerned in many of them, so that it is her duty to take part in their investigation.

Should a permanent organization be established, overlapping and duplication will be obviated, and, pending the establishment of the permanent body, a tentative Council has been set up, and composed of one representative from each of the following:—Hawaiian Territory, Australia, New Zealand, Philippine Islands, Japan, Canada, United States of America.

Mr. E. C. Andrews, B.A., of the Mines Department, Sydney, is the Australian representative on this Council.

The utmost courtesy and hospitality was extended to all the visiting delegates, and especially to those from Australia, as it was felt they had the greatest difficulties to overcome in order to attend.

A noteworthy feature of the Conference was the visit to the active volcano of Kilauea, on the island of Hawaii. This volcano is under constant observation by Professor Jaggar and his assistant, and much light has been thrown on the subject of volcanic activity by their observations. The visit of the delegates corresponded with the end of a particularly active period, and lava flows, which were quite hot, and in some cases still moving, were inspected.

Butter v. Margarine.

Experimental Feeding Trials.

The latest work of Otto F. Hunziker, B.S.A., M.S.A., formerly Professor of Dairy Husbandry, Purdue University, which was published in February, 1920, supplies the latest information on this much-debated subject. The following extracts are submitted for general information:—

"BIOLOGICAL PROPERTIES OF BUTTER.

Butter contains Growth-promoting and Curative Properties.—The butter-fat of butter contains certain biological properties which are not present in vegetable fats, nor in the ordinary animal fats. These properties are absolutely essential for an adequate diet. A diet that is lacking in these biological properties is inadequate to produce normal growth in the young, it prevents well-being of the adult, and gives rise to certain deficiency diseases.

By biological properties is meant those properties, recently discovered by McCollum, and subjected to extensive investigation by McCollum, Hart, Steenbock, Fink, Hopkins, Osborne, Mendel, and other nutrition experts and physiological chemists, which have to do with the life functions of the living organism. These properties cannot as yet be determined by any now known method of chemical analysis; their presence has only become recognised by means of experimental feeding trials with young animals.

These feeding trials, largely though not exclusively conducted with young white rats, showed that when the animals were put on an artificial diet containing all the chemical elements necessary for nutrition, both for maintenance and for growth, such as protein, carbo-hydrates, fats, and mineral salts, but in which the fat part of the ration consisted of a vegetable oil or of lard, the rats would, after a brief period, cease to grow, so that they rarely attained more than two-thirds of the normal growth of fully-grown rats. As this diet was continued, they would lose weight, and gradually develop sore eyes, which culminated in blindness and ultimate death of the rats. When, before the death of the rats, a portion of the animal or vegetable fat in the ration was replaced by butter or butter-fat, they recovered from their disease, gained in weight, and resumed their normal growing.

Fat-Soluble A.—Further experiments, in which the pure butter-fat was separated from the butter, and the butter-fat instead of the butter was used to replace a part of the lard in the feed ration, yielded identically the same results as in the case of butter, showing, therefore, that this growth-promoting and curative property of the butter is located in the butter-fat. Being soluble in the butter-fat, McCollum gave this unknown substance the name fat-soluble A.

Fat-Soluble A Present in Liquid Portion of Butter-fat.—Osborne and Mendel succeeded in concentrating the fat-soluble A substance contained in butter-fat by fractional crystallization of the fat from alcohol. They found that the fat-soluble A substance remains in the oily portions

—those portions which have a low melting point—while the other portions—those that have a high melting point—proved entirely ineffective. This fact assists in explaining why beef fat, which also contains small quantities of this substance, is much less effective in its growth-promoting powers than the butter-fat. The liquid portion in the beef fat is relatively small.

Fat-Soluble A Not Affected by Pasteurization, Neutralization, or Age.—Additional experiments showed that the fat-soluble A substance is of a stable nature, and that it is neither destroyed, nor its growth-promoting and curative effect lessened by heat, saponification, or age.

Butter-fat boiled with live steam for several hours did not lose its biological properties. This is important, because it demonstrates conclusively that the pasteurization of cream does not rob the resulting butter of its growth-promoting and curative properties. Pasteurized cream butter is equally valuable, therefore, from the dietary stand-point as raw cream butter.

Butter-fat or butter, when completely saponified into a soap by admixture of alkali in excess, fully retains its growth-promoting and curative properties. Butter soap so made, when fed to the rats, had the same biological effect as normal butter or pure butter-fat. This fact is important, because it removes every vestige of doubt that the reduction of the acid in sour cream by the use of an alkali, as practised in so-called neutralization of sour cream, in no way destroys or weakens the growth-promoting and curative properties of butter. Butter made from sour cream that has been neutralized has equal dietary value as butter made from cream that was not neutralized. Age does not change the biological value of butter. The changes which butter undergoes in storage fail to deprive it of its growth-promoting and curative effect. Butter-fat held in the cold and at room temperature, in the light and in the dark, for ten months, when subsequently fed to rats which had ceased to grow and had developed the characteristic sore eyes as the result of the absence in their diet of the fat-soluble A, brought about resumption of growth to normal stature, and recovery and healing of the eyes. The biological potency in all samples of butter-fat held in storage was retained, and was equal to that of fresh butter or fresh butter-fat. This fact is important, because it furnishes indisputable proof that storage butter, relative to biological properties, is equally wholesome as fresh butter.

Other Sources of Fat-Soluble A.—The only substances in which the fat-soluble A has been found, other than butter and butter-fat, are the fat contained in the yolk of the egg, cod-liver oil, leaves of plants, and the fat of the vital organs.

So-called Butter Substitutes cannot take the Place of Butter.—This discussion makes it clear that there is no substitute for butter. So-called butter substitutes, all of which are largely made up of vegetable or animal fats, or both, cannot take the place of butter. They may have equal, or nearly equal, caloric value as butter, but they lack this most important property, the fat-soluble A, without which the diet is not complete. Their substitution for butter in the diet of the family is jeopardizing the well-being, vitality, and maximum mental and physical development and vigour of the child, and to that extent limits the future greatness of the nation."

Paper Manufacture in Australia.

[Mr. I. H. Boas, officer in charge of Forest Products Investigations, Institute of Science and Industry, has supplied the following comment upon paper manufacture in Australia.]

Australia has never made any serious effort to supply her own needs in the way of paper. There are a couple of mills using imported pulp making brown papers, and also a few making boards from straw, waste rags and paper, and such materials. It is necessary to stress this as such failures are held up by those whose interests would not be served by the establishment of an Australian paper-making industry, as showing that such an industry is not economically possible.

So long as newsprint could be sold in Australia at about £11 a ton. and other papers at corresponding rates, there was considerable doubt as to whether the industry was possible. Australia has no large supplies of softwoods, which are used all the world over for paper making. and which are undoubtedly superior for this purpose to the hardwoods. Softwoods can, of course, be grown here, as has been demonstrated by plantations in most of the States. It would, however, take many years before sufficient could be grown to supply even a portion of Australia's needs. It is necessary then to demonstrate the economic possibility of the hardwoods which abound in the Commonwealth. It is a maxim in the paper trade, that hardwoods cannot be used. This is not true. but it really expresses the fact that where there are softwoods in plenty. the hardwoods cannot compete with them. Everywhere one meets with discouragement when suggesting the use of hardwoods, but for some years thousands of tons of poplar have been used in the States, and as the softwoods grow dearer and scarcer, more of the former must be used. Recently one of the largest paper companies in Canada has been experimenting with hardwoods for mechanical pulp, and with considerable success, and now this company is using 15 per cent of hardwood in its pulp for newsprint. Canada has more pulp wood reserves than any other country, and yet a beginning has been made in using hardwoods. There is little doubt that the proportion used will be gradually extended.

Granted the possibility of using hardwoods, there is nothing to prevent the growth of paper making in Australia. The price of labour in Australia is lower than in America, Canada and Norway, where the industry is chiefly centred.

There are not a great many places in Australia suitable, as large supplies of good water are essential. There are a few places, however, where these can be found in reasonable proximity to wood supplies.

The Institute of Science and Industry has begun experiments into the paper-making qualities of Australian woods. The work is being carried out in Perth, Western Australia. So far no paper machine has been available, and the work has been mostly confined to pulping and bleaching experiments, and such papers as have been made have

been hand made. By the generosity of the principal newspaper companies of Western Australia a model machine has been purchased, and will soon be erected at the paper laboratory. Already autoclaves for cooking the wood, a beater and bleacher, and all the chemical plant for testing, have been installed, and a great deal of preliminary work has been done. Karri and Jarrah have been investigated, and now Spotted Gum and Blackbutt from New South Wales, and Mountain Ash from Victoria, are being tested. In addition a good many grasses and other longer fibred materials are being examined to find a suitable material for blending with the short fibred hardwood pulps, to make a tougher paper.

A great deal of work has to be done to gain the necessary technical experience, and good progress has been made in this direction. The results so far obtained indicate that several of our hardwoods yield a high percentage of readily bleached pulp, which would make good book, magazine, or writing papers. The question of newsprint has not yet been tested, owing to lack of necessary plant. This will soon be obtainable.

It is too soon yet to state definitely what the economic possibilities are, but it is safe to say from results obtained, that if a mill were to be erected to work on imported pulp, there is no doubt that at the start it would use a fair proportion of local pulp, and as further knowledge is obtained, this proportion could be largely increased. This industry would, if established, give employment to many men. It would, moreover, make use of much timber now wasted, and help the forest departments to more economically manage the forests, and prevent fires, those deadly enemies of the forest. It would also help in keeping down the price of paper, which enters so largely into the life of the community. Lastly, it would destroy another of the fallacies that help to prevent the establishment of industries in Australia utilizing local raw materials.

Mildura Research Committee.

Experiments with the Drying of Vine Fruits.

By A. V. LYON, B.Ag.Sc.

[The following interim report of the work being carried out by the Mildura Research Committee, in co-operation with the Institute of Science and Industry and the Victorian Department of Agriculture, contributes some important information on the various processes of drying vine fruits. Two of the principal problems dealt with have reference to the estimation of loss in weight in process of drying and the dipping strength for sultanas.]

Experimental work in connexion with the drying of Zante currants and sultanas has been in progress for the past two seasons. The following progress report shows the aim and extent of the investigations.

The problems attacked were as follow:—

1. (*a*) Estimation of loss in weight in process of drying. (*b*) Relationship of the density of the grape juice to the loss of weight on drying.
2. *Dipping Strength for Sultanas.*—Relationship of the density of the grape juice and the concentration of caustic-soda solution (at or near boiling point) which will give satisfactory results.
3. Relationship of the strength and temperature of dip to colour of dried fruit (sultanas).

Loss of Weight in Process of Drying.

The following work was undertaken on each of a number of samples of sultanas and Zante currants in the drying season of 1919 and 1920:—

The density of the grape juice was obtained by means of a Pyknometer, and the corresponding Baumé reading was calculated from the formula—

$$\text{Degrees Baumé} = 145 - \frac{145}{\text{D.}\dfrac{60^\circ}{60^\circ}\text{F.}} \qquad \text{(Circular 19 Bureau of Standards).}$$

The calculated result was taken as a measure of the ripeness, as the density increased as the grapes ripened.

The sample of fruit for testing was, in each case, composed of berries without signs of wilt, as obviously the density of the juice increases as wilting progresses.

The fruit (about 2 cwt. green) was weighed at the green and at the dried stage (unstemmed). Determination of the suitable end point of drying presents difficulty, as the samples should be dried to a corresponding degree in order that comparisons may be made.

In field practice, this stage is judged by sight and feel (slight squeezing of a handful). This method was adopted throughout these experiments; but the judgment of the experimentalist was tested by further exposure of the dried fruit, for four hours, *to note loss, if appreciable.*

(1) If *this* loss in clear dry weather amounts to 1½ per cent., it may be assumed that the fruit at the first weighing was insufficiently dry. The variation in weight when fruit distinctly under-dried is exposed until distinctly over-dried amounts to 5 or 6 per cent.

(2) The correct stage within this range depends on the judgment of the experimentalist, though he may be guided by the fact that the first step in loss of weight (from under-dried to suitably dried) takes place relatively more quickly than the second step (from suitably dried to over-dried).

(3) With the equipment of the laboratory at Mildura it will be possible in future work to secure uniform results by measuring the amount of moisture in the dried samples.

The following results were obtained, and are typical of the general results:—

	A. Sultanas.		B. Zante Currants.	
	Baumé Reading.	Weight of Green Fruit. / Weight of Dried Fruit.	Baumé Reading.	Weight of Green Fruit / Weight of Dried Fruit.
1	11.8*	4.75	11*	4.87
2	12.1*	4.22	13.1*	4.10
3	13.2	3.69	13.3*	4.17
4	13.8	3.47	14.5	2.93
5	14.15	3.40	14.75	2.80
6	14.2	3.42	16	2.52
7	14.75	3.31	16	2.58

* Not paying.

(4) *Discussion of Results.*—To secure the maximum weight of dried fruit of good quality is obviously the aim of the viticulturist. The above results indicate that picking at an early stage (under 13 Baumé) is not a paying proposition in the case of sultanas. Generally speaking, the Baumé reading for currants is on a higher level (about 1°) than that of sultanas. Results indicate that, in the case of Zante currants, a Baumé reading of 14 shows the minimum stage of ripeness at which they can be profitably harvested.

Dipping Strength for Sultanas.

In field practice it is customary to dip the buckets of fruit in a caustic-soda solution at or just under boiling point, or to dip at a lower temperature (190°-195° F.), which involves the use of a thermometer. At the lower temperature, 15 to 20 per cent. increase in quantity of caustic soda is required to give results similar to those obtained with the boiling dip. The desired condition prevails when the concentration of the dip is such that after immersion slight cracks

(almost imperceptible) appear on a fair proportion of the berries. If fruit be not cracked, the process of drying is prolonged; if over-cracked, the exposure of sugar results. In the latter case, the keeping qualities of the fruit are probably affected, as granulation and massing are more likely to result when the sugar of separate berries can be brought into close contact. An additional fault in over-cracked fruit is the liability to collect dust on the exposed sugary surfaces while on the drying green. In the case of perfectly cured berries, this dust is largely removed in the process of stemming and grading. The raising of dust on the drying green appears to be inevitable, since heavy loads of fruit are brought in at frequent intervals. Much good, however, could be done by erecting the separate portions of the drying plant in such positions that a minimum of traffic takes place in the immediate vicinity of the racks. The procedure adopted by the experimentalist was to immerse a dip-tin of sultanas for two seconds. It is inevitable by this method that the bunches in the bottom of the bucket receive a slightly longer immersion than those on the top. This difficulty was overcome to some extent by inclining the tin, introducing the end into the solution, and passing the tin through the liquid in the form of a curve. This practice is adopted by the majority of dip men. In this set of experiments, the following course was adopted with each sample:—A weak solution of caustic soda (1 in 60) was prepared, and the solution was strengthened, as required, by adding an amount of caustic soda calculated to reduce the water relatively by 5 gallons to each 1 lb. of caustic soda. Trials were made at each strength, and the additions were continued until the berries became over-cracked. Maximum and minimum concentrations were recorded, representing the range in concentration within which results were adjudged as satisfactory. All dipping was done at boiling point. The figures obtained were as follow:—

Baumé Reading (as gallons of water to 1 lb. of caustic soda, measure of **ripeness**). (Commercial 99 per cent.)

	(a) First Cracking.	(b) Approaching Over-cracking.
12.1	60	40
13.2	50	35
13.8	45	35
14.15	40	30
14.2	40	30
14.75	30	20

Results show that there is a considerable range for a satisfactory dip at each stage of ripening. The cracks in the berries increased in number rather than in size, as the dip was concentrated over the ranges given above. Variation in the lower figure will naturally occur according to the variations in the judgments of investigators. In the case of these experiments, the dip was held to be too strong when long transverse cracks appeared. The minimum concentration (set *a*) can safely be taken as a guide to a commencing dip. In field practice there is apparently no advantage in maintaining an exact concentration for each stage of ripeness. It will be sufficient to keep within the limits mentioned above.

Alterations of Concentration of Dip.—Addition of both caustic soda and water are necessary as the dip is being used. To make these additions without altering the concentration of the dip to a harmful extent. presents difficulty. In many cases too much caustic soda is added. Dilution by addition of cold water is then practicable, but this causes delay until the dip again boils. The other alternative (continuation of work and over-cracking of berries) is too often accepted. The harmful effects of this has been referred to elsewhere.

In the operation of dipping, the solution in the tank is affected as follows:—

1. There is concentration by evaporation of water.

2. The volume of the solution is decreased by the removal of the quantity which wets the bunches.

3. There is probably some slight neutralization of the caustic soda by fruit acids.

The net result is a concentration in strength and a considerable diminution in volume.

An attempt to meet the problem was made as follows:—A dip tank was filled to the 50-gallon mark with a solution of 1 lb. of caustic soda to 30 gallons of water. One hundred buckets of sultanas were dipped, and water was added to make up to the 50-gallon mark. A second 100 buckets were dipped, and tank again made up to the 50-gallon mark with water. Three samples of the dip were taken.

Sample 1. At commencement of operations.

Sample 2. After addition of water, 100 buckets having been dipped.

Sample 3. After second addition of water, 200 buckets having been dipped.

Sultana grapes (Baumé 14.3) were used in this test, and all dipping was done at boiling point.

The alkalinity of the various samples was determined comparatively by titration with dilute H_2SO_4.

Discussion of Results.—Results indicate that 1 lb. of caustic soda was removed by 300 buckets (approximately). This work is at present incomplete. Application on a larger scale and subsequent testing under field conditions is necessary for confirmation.

Relationship of Strength and Temperature of Dip to Colour of Dried Product.—The colour of dried fruit is dependent on a number of factors. Chief among these are—

(*a*) Conditions of green fruit (vigour, stage of ripening, sugar content, uniformity).
(*b*) Weather during the drying period.
(*c*) Distribution on drying rack.
(*d*) Fungoid diseases due to attacks by parasitic fungi in fields and saprophytic fungi on rack.
(*e*) Strength and temperature of dip.

Discussion of Factors.—On vineyards which have been under cultivation for a number of years fruit frequently shows non-uniformity of ripening, low sugar content, and want of vigour (shown by early wilting of berries). Obviously, on well-kept and well-manured vineyards, these

harmful conditions are not so much in evidence. No great attempt has been made to specify the particular manurial operations necessary to secure fulfilment of the early promise of good yield, which invariably shows on old vines.

The weather is an important factor. On the majority of fruit-drying settlements bad drying weather is the exception. Trials in the use of evaporators have been made at Pyap (South Australia) by Messrs. Williams, Beverly, and Short. Their results up to date indicate that it may be payable to put evaporators into general usage, or, at any rate, to install the plant for use should bad weather arise.

On the question of spreading on the rack, it is generally admitted that thin even spreading gives best results. Shortage of rack room is often responsible for the overloading of racks. Obviously, uniformity in rate of drying and in colour cannot be obtained when some bunches are buried.

Diseased fruit invariably produces a bad sample.

The effects of the saprophytic fungi can be largely minimized in bad drying weather by thin spreading, by complete covering during rain, and by a maximum of exposure to sunshine and light as soon as possible after the weather clears. The losses through the various moulds are very great, amounting to 20 per cent. in bad cases, and, in addition, considerable variation in colour results.

The foregoing will show that the strength of dip is but one of a number of factors controlling the resultant colour of the dried product.

Generally speaking, the quicker the process of drying the *higher* and more even the colour. Unduly weak dips are to be avoided, as they lengthen the drying period. Unduly strong dips certainly will hasten drying and help to give a good colour, but they must be avoided for reasons previously mentioned.

Summary.—Reviewing all the features in the whole process, the following points are chosen as tending, in the case of a great many growers, to secure better results than are at present forthcoming:—

1. Apply the Baumé test as a measure for ripeness, and delay picking, except in unusual circumstances, until juice gives a satisfactory test.

2. Avoid over-cracking and under-cracking of berries. The range of concentration for a suitable strength of dip is a wide one at all stages of ripeness, but mistakes must occur unless the dip is made up by measurement or by very careful trial.

3. Clean out the dip frequently (at least every two days, if in continuous use), as variation of concentration cannot be avoided. The dip can then be re-made at a suitable strength.

4. Vineyards well cultivated and well manured give a more even sample of fruit.

5. Racks should be so placed that they receive a minimum of dust, and dried fruit being taken to the packing sheds should certainly be covered.

6. Sufficient rack space should be provided to secure thin spreading.

The work will be continued, with the additions mentioned, and a further report made at a later date.

Scientific and Technical Societies.

LINNEAN SOCIETY OF NEW SOUTH WALES.

At the September meeting the following papers were read:—

1. The Chemical Examination of *Macrozamia spiralis*, by James M. Petrie, D.Sc., F.I.C., Linnean Macleay Fellow of the Society in Biochemistry.

Macrozamia spiralis has been regarded as a poisonous plant from the earliest days of the State, and a complete summary of its poisonous record is given. In the leaves the following constituents were identified:—Formic, acetic, valerianic, and lauric acids; oleic, stearic, and higher fatty acids; a volatile essential oil; a phytosterol; a paraffin with the properties of triacontane and an olefine having the properties of octodecylene. The nuts contained 39 per cent. of starch and much mucilage. In feeding experiments, white rats were given, with their ordinary food, (1) crushed fresh leaves, (2) grated seeds, (3) the rich, fatty, and resinous components extracted from the leaves by ether, and (4) aqueous extracts of the leaves and the seeds. The animals showed no signs of being affected after feeding for three weeks.

2. Two new Hymenoptera of the superfamily *Proctotrypidæ* from Australia, by Alan P. Dodd. (*Communicated by W. W. Froggatt, F.L.S.*)

A new genus is proposed in the family *Diapriidæ*, and a new species of *Prosoxylabis* (*Belytidæ*), the former being a primary parasite of the sheep-maggot flies.

3. The Geology and Petrology of the Great Serpentine Belt of New South Wales. Part IX. The Geology, Palæontology, and Petrography of the Currabubula District, with notes on adjacent Regions. By Professor W. N. Benson, D.Sc., F.G.S., W. S. Dun, and W. R. Browne, B.Sc., Section C. Petrography (W. R. Browne).

The extrusive rocks comprise keratophyric tuffs of the Burindi and Kuttung series, with which are interbedded soda rhyolite flows and tuffs and basalt. The Werrie series consists of very decomposed basalts, occasionally slaggy. Invading these and also the underlying Kuttung and Burindi beds is an immense series of sills and dykes comprising quartz keratophyre, quartz trachyte, quartz latite, andesite, lamprophyre, normal and albite dolerite, teschenite and basalt. Attention is drawn to the peculiar association of calcic and alkaline rock-types linked by intermediate types and evidently derived from a common stock magma. Though the dominant rocks in this area are intrusive, and those in the Paterson, Seaham, and Pokolbin districts are effusive, the petrographical similarity of the Carboniferous igneous rocks in the two districts is most marked.

4. Descriptions of new species of Australian Coleoptera. Part XVI. By Arthur M. Lea, F.E.S.

Nineteen species and one variety of *Ditropidus*, 3 species of *Elaphodes*, and 3 species of *Cœnobius* are described as new. In addition, notes on synonymy, &c., partly the result of examination of some of Macleay's and Olliff's types from the Australian Museum, are given for 71 species belonging to 22 genera.

ROYAL SOCIETY OF SOUTH AUSTRALIA.

At the September meeting the following papers were read:—

1. "Autoclastic, Intraformational, Enterolithic, and Desiccation Breccias and Conglomerates," by Professor Walter Howchin.

The paper dealt with the literature of the subject and the numerous terms that were in use relating to the phenomena. A classification was suggested under two main headings, based on their respective origins, viz.: I. *Syngenetic.* (Deformation contemporaneous with deposition.) II. *Exogenetic.* (Deformations that occur subsequent to deposition.) Some South Australian examples were exhibited and described.

2. "*Ditropidus* and Allied Genera (Coleoptera, *Chryso melidæ*," by Arthur M. Lea, F.E.S.

The paper contains descriptions of one new genus and 39 new species of leaf-eating beetles.

3. "A Review of *Chiton crispus* Rv. (Order Polyplacophora) and its allies, with descriptions of three new species," by Edwin Ashby, F.L.S., M.B.O.U.

This paper is the result of the examination by the author of many thousands of specimens of this group of most variable Ischnochitons.

The series dealt with range from North of Brisbane in Queensland round the coast to Esperance Bay in Western Australia. And from the southern side of Bass Straits round the Tasmanian coast to the D'Entrecasteaux Channel.

An attempt has been made to assign the limits of their respective habitats, and to define their distinguishing characteristics. A concise summary of these latter is given in the form of a table at the close of the paper.

4. "An Observation on the Toning of Photographic Silver Images," by Arthur R. Riddle.

Among the exhibits were a plant *Chara* (stonewort) grown from a spore that had been kept dry in a tobacco tin for 12 years, and a tadpole, the development of whose legs had been accelerated by the administration of a dose of thyroid extract. Both these were shown by Mr. A. G. Edquist

ROYAL SOCIETY OF TASMANIA.

At the September meeting the following papers were read:—

1. *Nototherium Mitchelli,* The Apendicular skeleton, including the manus and pes (hitherto unknown), by H. H. Scott and Clive Lord.

The paper dealt in detail with the osteological formations of the feet of the Nototheria. These have never previously been described, although there are many separate bones in museum collections which have been relegated to the genus. After describing in detail the various characteristics of these, and other portions of the specimen under review, the authors append various recapitulative notes on their studies to date. In the course of these they point out that their aim has been to show that the rhinoceros type was not absent from the fauna of Australia in ages past. True to the structural type of the country, the animals retained the marsupial habit, simply grafting on to it the results of that evolutionary trend that has culminated in other lands in the Perissodactylan lengulates. Just how many groups Australia could boast of we cannot say, but apparently two at least were well segregated at the time extinction overtook the race. One of these, the *Megacerathine* group, manifested more development along the fighting trend than did the second or *Leptocerathine* group did; this is noticeable chiefly in the alterations to the nasal bones for the attachment of the horn, the extra strengthening of the neck, the general enlargement of the whole skeleton to maintain a suitable poise, the dilation of the skull walls to provide extra air cells to deaden shock and to combine lightness with strength. America is said to have elaborated seven groups of rhinoceros-like animals. It remains for the future to say what number actually existed in the Australian Zoogeographical province. As far as we know we have fairly and impartially weighed every fact of importance recorded by any or all workers in this particular branch of palæontology, and the final result has been the several views expressed in our short series of papers of which the present constitutes No. 4. At a later stage we hope that circumstances will permit the whole question to be dealt with in the form of a monograph.

For the scientific use of the skeleton of *Nototherium Mitchelli* we are indebted to Mr. K. M. Harrisson, of Smithton, who generously placed the specimens at our disposal for the purpose named. Mr. Harrisson has also presented the whole of the remains to the Tasmanian Museum, Hobart, with a view to their future exhibition in that institution.

2. A descriptive catalogue of the osteological specimens relating to *Homo Tasmaniensis*, contained in the Tasmanian Museum, by W. Lodewyk Crowther, D.S.O., M.B., and Clive Lord.

For their introductory remarks the authors state that during the course of the preparation of a paper dealing with certain recent valuable additions to the Tasmanian Museum, it became necessary to revise the complete collection of the osteological specimens relating to the Tasmanian aboriginals.

The present list forms a record of the largest single collection of osteological remains of the extinct Tasmanian aboriginals. It embraces also, specimens concerning which data is being gathered for publication. Again, in the course of the work, additional particulars have been added to specimens already described in part. With the exception of the researches of Harper and Clarke, and, later, of Berry and Robertson, on certain of the crania included in this list, none of the specimens have previously been described.

The main portion of the paper deals with 361 osteological specimens relating to the Tasmanian aboriginals—each bone being described.

ROYAL SOCIETY OF VICTORIA.

At the August meeting the following papers were read:—

1. Organization of Science in Australia, by Professor T. H. Laby, M.A.
2. Note on the "Dimpling" of Granite Hills in Sub-Arid Australia, by J. T. Jutson.

Low scattered isolated hills of granite, practically bare of vegetation, occur in sub-arid Western Australia. They have the rounded outline and the boulders due to spheroidal weathering, but, in addition, some have a distinctly dimpled appearance, due to the occurrence upon the sides of the hills of rock holes of various shapes and sizes. These holes or "dimples" may be scattered, or may be arranged along definite lines (*e.g.*, a drainage furrow in the hillside). The "dimples" are a variety of the normal rock or "gnamma" holes common in granite areas in inland Western Australia. The various views as to the latter, *i.e.*, differential erosion, solution, and effect of joints, are briefly stated, and held to apply, to some extent, at least, to the formation of the "dimples," except that the effect of jointing has not been noticed, and also that the mechanical action of water, where the dimples are in a furrow of erosion, must, to some extent, be responsible when the holes overflow after heavy rain, and the water passes from one hole to another by a series of low waterfalls.

3. An example of Gravitational Drift of Rock *Débris* in Parallel Lines in Sub-Arid Western Australia, by T. J. T. Jutson.

Gravitational Drift of Rock Débris in General.—A widespread surface covering of rock fragments is one of the commonest features in sub-arid Western Australia. It is due to the slow gravitational drift of the fragments, and to the removal of the fine material by rain and wind. Only the hardest rocks travel any distance. As a general rule there is no particular arrangement of the rock fragments, but an exception to this is the subject of the paper.

Gravitational Drift of Rock Débris in Parallel Lines.—The example occurs on the floor of Lake Goongarrie on the eastern side of a quartz reef, which runs parallel to the strike, which is N.10°W. of the enclosing indurated black shales. The shale floor is gently inclined to the east from the reef, and the *débris* from the reef is travelling in parallel lines down this slope. There are alternate bands of this quartz *débris*, and of practically bare black shales. It is suggested that the shales are being differentially eroded by ordinary weathering along their line of strike, and that the wind sweeps the material away, forming a furrow, and at the same time undermines the quartz fragments, which then topple forward into the furrow. The "ridge," lately occupied by the quartz, then becomes furrowed, and then again becomes occupied by quartz fragments. Thus the parallelism is maintained. As rain must flow across the furrows, it cannot be responsible for the latter. One objection to the suggested explanation is the difficulty of understanding how the parallelism can be maintained even under the special conditions postulated. The matter is brought forward so that further instances may be found and studied. So far as known to the writer, there is no similar record.

At the September meeting the following papers were read:—

1. Possibilities of Modifying Climate by Human Agency, with Special Application to South-Eastern Australia, by E. T. Quayle, B.A.

The author seeks to prove—

(*a*) That the clearing away of the Mallee forest covering, and the substitution therefor of growing crops and grass, cause a very appreciable increase in the rainfall over the country to leeward of the improved area, especially in spring.

(*b*) That similar results are observable in connexion with the irrigation areas and Murray floodings.

(*c*) That the increased evaporation from these areas mostly causes increased rainfall upon the mountains, and, therefore, results in increases in the water supplies available for irrigation.

These claims are effectively supported by rainfall statistics, and by arguments based upon analyses of rain incidence with the various winds upon the shores of Port Phillip Bay and Spencer Gulf, proofs being quoted that wet soils and growing vegetation evaporate as freely as water surfaces.

Stress is laid upon the economic importance of these results.

2. Revision of the Genus Pultenæa, Part II., by H. B. Williamson.

About thirty species of Pultenæa are dealt with in continuation of the previous paper. Affinities are discussed, and by means of short descriptions and diagnostic drawings it is sought to clear up many confused ideas regarding the genus. Four new species are described and five new varieties defined. Two species have been reduced to varietal rank, and one species has been restored.

Mr. F. Chapman exhibited some remarkably well preserved fossil leaves, in which the venation stood out very distinctly. It was stated that this feature of the clear venation seems to be due to the absorbent condition of the pipe-clay matrix, which separates the humic acid and other products of partial decomposition. The leaves shown were all of Triassic age (Ipswich series), from Petrie's Quarry, Brisbane, and included the Maidenhair trees and allies (Ginkgo and Baiera) and a Fern, Tæniopteris.

Mr. H. Barkley exhibited some interesting examples of Fractures in Glass.

ROYAL SOCIETY OF NEW SOUTH WALES.

At the September meeting the following papers were read:—

1. "The Volcanic Neck at the Basin, Nepean River," by Mr. G. D Osborne.

The general geological features of the neck were discussed, and a detailed account of the petrology of the rocks occurring there is given.

The neck, which breaks through the Triassic rocks at its surface outcrop, is filled with a fine-grained breccia, which is intruded by basalt dykes and plugs. The formation of the neck with the production of a long narrow vent has been effected by explosive action concentrated upon a weak fissure stricture lying transverse to the monoclinal fold in that locality.

The Basin Neck has played an important part in the physiographic history of the Warrangamba and Nepean River systems in Cainozoic times, the present junction of these two rivers being within the Neck.

The neck, one manifestation of Tertiary vulcanicity, is genetically connected with the differential epeirogenic disturbance and quasi-senkungsfeld formation which affected the Sydney-Blue Mountain area in Tertiary times.

In the breccia there occur fragments of the peridotites cognate with basalt, and foreign xenoliths of rhyolite, gneissic granite, and sandy limestone. The basalt contains only cognate inclusions of norites, hyperite, harzburgites, herzolites, dunites, pyroxenites, and troctolite, the latter recorded for the first time in New South Wales. The cognate inclusions represent fragments of a differentiate which solidified under plutonic conditions. The rhyolite inclusions may have come from the southward extension of the Kuttung series, the granitic rocks from ancient terranes, and the calcareous clastic rocks from a now denuded roof of upper Wianamatta rocks.

Chief among petrographical features are the occurrences of two mineral intergrowths, viz., a granophyric one of pleonaste and diopside, and a graphic intergrowth of augite and picotite.

2. Mr. R. H. Cambage, F.L.S., read a paper on Acacia Seedlings, Part VI., in which the seedlings of seven Acacia species are described.

He stated that one seed pod of *Acacia Farnesiana* had floated in sea water for over eleven weeks, and another for over twelve weeks; and, as he had previously demonstrated that a seed of that species would germinate after having been immersed in sea water for three and three-quarter years, he considered the likelihood of the distribution of this species being sometimes effected by ocean currents was strengthened. The twinning of seedlings of *Acacia asparagoides* was recorded, several seeds having produced twin plants.

3. "On a Box Tree from New South Wales and Queensland," by J. H. Maiden, F.R.S.

This tree, which is described as a new species, seems to deserve the name of "Narrow-leaved Box" better than all the boxes, its juvenile leaves being narrow-lanceolate, and its mature foliage almost as narrow. The fruits are small, and timber pale brown. It is one of the trees known as "Mallee Box." It differs from *Eucalyptus bicolor*, which has narrow juvenile foliage, in the red timber and thick bark of the latter, and is widely different from *E. Woollsiana*, R. T. Baker, which has broad juvenile foliage. It has been collected from Gilgandra, New South Wales, to Southern Queensland, and it is particularly abundant in the Pilliga scrub. The type comes from Narrabri, New South Wales.

Munitions of Peace.

How the Deadly T.N.T. can be put on its Good Behaviour and Made to Work for its Living.

By C. H. CLAUDY.*

THE world is but beginning to make use of its war-developed ideas for peace-time pursuits. It was the war impetus to aviation which made transoceanic flights possible. The war developed the radio telephone to a practical basis. It was war which showed this nation how to build ships and build them quickly. It was the effect of the war which produced a revolution of trade practices, and convinced even ardent trades unionists that the artificial restrictions of apprenticeship measured in years where months would do was a mistake, though perhaps this realization came more in England than in this country.

It is one of the pleasant functions of peace to make use of the developments of the art of war, but it is seldom that peace can use the material of war. Peace hath no use of great guns, nor for shells, nor for armies, nor even for submarines. But peace may use the very tool of tools of war itself, if only peace will believe it. The adaptation of T.N.T. the terrible to peaceful work is one of the oddities of the aftermath of the great conflict.

T.N.T.—short for tri-nitro-toluol—came into public notice only with the great war, although it has been known as an explosive since the Civil War, at least in the laboratory. But it remained for the great conflict to bring it into prominence, which was done because it offered an unusual degree of safety to the user, plus an efficiency as a bursting charge for high explosive shell, depth bombs, mines, torpedoes, and similar devices slightly greater than that of other well-known explosives.

The reader may be surprised to hear T.N.T. spoken of as a "safe" explosive. During the war there were, it is true, many disastrous explosions in both the manufacture and transportation, even in the quiet storage, of T.N.T. But the explosions were due to the hurry and carelessness of speed and emergency, not to inherent lack of safety in the explosive. Had, for instance, dynamite or plain nitro-glycerine been similarly handled, there is small doubt that the unfortunate explosions would have been vastly greater in number. Neither nitro-glycerine, dynamite, nor gun-cotton will stand what T.N.T. will stand, which is the best reason in the world why this most terrible of war's weapons should find a secure place for itself in the uses of peace.

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* *Scientific American.*

But its industrial use is new and almost untried, and because of the name of terror it acquired during the war, many who would handle the familiar dynamite of the mine, the blast, the quarry, the tree stump, the log split, or the ditch-digging operation fearlessly, shrink from T.N.T. That they shrink without real cause has been demonstrated by careful and exhaustive tests conducted by the Bureau of Mines, which has shown that it may not only be employed with greater safety but with greater effect than the familiar explosives of industrial use.

Without going very deeply into the chemistry of the substance, it may yet be interesting to consider it for a moment as a substance rather than as an explosive. T.N.T. is produced by the action of nitric acid upon toluene in the presence of sulphuric acid. Toluene is a soft-coal product, obtained as a by-product in the manufacturing of coke, coal gas, and coal tar. There are many nitro-toluenes, hence the distinguishing of this particular one by the "tri" which indicates its chemical composition.

It appears as a pale, yellow crystalline substance, which darkens to a deeper yellow and a brown under the action of light. It is very slightly soluble in water, melts at about 177.9 degrees Fahrenheit, and can be cast, like any molten metal, when so melted, or dropped into water and solidified in globules or pellets. The T.N.T. allotted to the Interior Department by the War Department from its large war-provided store, for allocation to peace uses by various Government activities, such as the Office of Public Roads, the Reclamation Service, the Indian Office, &c., is in three grades, differing in the temperature at which it solidifies, and in purity. Pure T.N.T. has a faint odour, tastes bitter, something like quinine without the permeability of that chemical on the mucous membrane, and is to some extent poisonous, though not fatally so without large quantities or great exposure. Nitro-glycerine is so powerful a heart stimulant as to find a place in materia medica, and, as is well known, produces severe headaches when allowed to come in contact with the person. T.N.T. requires a much longer exposure to produce its characteristic effect—a rash or skin breaking out—and can be handled without danger if gloves are worn, and it is not allowed to touch mouth, nose, or eyes.

T.N.T. needs a more powerful detonator than either nitro-glycerine or dynamite. The statement that the extra powerful detonation required for T.N.T. means increased expense for use is hardly borne out by the facts. A couple of pennies covers the extra charge (no pun is intended) with something to spare.

T.N.T. is not so sensitive to friction as 40 per cent. straight dynamite (the familiar explosive of blasting operations), gelatine dynamite, or even picric acid. It is less sensitive to percussion than the dynamite and several other well-known explosives. It may be fired and burn peacefully, but it may be fired and turn its flame to a detonation, so it cannot be said to be fireproof. The results of the explosion of T.N.T. are six different gases: carbon-dioxide, oxygen, carbon-monoxide, hydrogen, methane, and nitrogen. The proportion of the poisonous gases produced is about forty-six to fifty-four of the non-poisonous. Forty-six per cent. of poisonous gas as a result of an explosion is too

much to permit the explosive so resulting being used safely in confined or underground work, unless ventilation is very good, or plenty of time can be permitted to allow the poisonous vapours to dissipate.

The efficiency of T.N.T. compared to other similar explosives is high. The Bureau of Mines determines relative efficiencies by comparing what is termed the "unit deflective charge" and the "rate of detonation." The first is defined as "that weight of an explosive which will swing the ballistic pendulum the same distance as one half-pound 40 per cent. straight nitro-glycerine dynamite." In other words, the less the unit deflective charge the greater is the propulsive capacity of the explosive. Different grades of T.N.T. give results varying from 109 to 114 as compared with 100 for 40 per cent. dynamite.

"Rate of detonation" is a measure of the ability of an explosive to disrupt or shatter material in which it is exploded. In other words, it is not only the amount of force exerted which counts in an explosive, but time during which it acts. A very homely example will make this clear. Supposing a piano weighing 1,000 pounds requires a push of 100 pounds to start it rolling across the floor. If a man push slowly until he exerts that required 100-pound rolling pressure, the piano will move. But if he hit it with a 10-pound sledge hammer, with a sufficient force to exert a pressure of 100 pounds on the end, he will not move the instrument, but shatter the wooden end of it.

It is so with an explosive. It is not only the unit deflective charge which is of use, but the rate at which that developed pressure takes effect. In blowing up a boulder of rock, a slow explosive may exert plenty of pressure and move the rock, while another, with half the pressure, but much more suddenly applied, may not succeed in moving the mass at all, as a mass, but will shatter it to fragments.

Rate of detonation is measured in meters per second, and with 40 per cent. dynamite on a scale of 100 T.N.T. grades from 94 to 102, according to quality. The rate of detonation of 40 per cent. dynamite is about 4,772 meters per second, and T.N.T. varies from 4,482 to 4,852 meters per second—approximately the same.

It is the shattering effect which made T.N.T. depth bombs so valuable in anti-submarine warfare. Several times as much gunpowder, for instance, in an ordinary "depth bomb" would, if exploded, in the same position do much less damage. It is the tremendous shattering effect of detonating compounds, such, for instance, as fulminate of mercury, which makes them valuable in setting off other explosives which have to be heavily jarred to explode.

T.N.T. resists dampness very well, and therefore can be used in damp holes, with proper precautions not to break cartridge cases. When exploded, T.N.T. gives off dense volumes of black smoke.

It may be interesting, as giving an idea of the real power of such "high" explosives as are here under consideration, to notice for a moment the results of what is known as the Trauzl block tests. Cavities are made in blocks of lead and various explosives set off within these cavities. The increase of volume in the size of the cavity of a substance like lead, which stretches with great resistance without shattering,

is a measure of the force of the explosive, and, on a basis of comparison, enables the chemist to determine the relative efficiencies of the various compounds tested.

Forty per cent. straight dynamite is here as elsewhere the comparison standard. Fifty per cent. dynamite rates 105.2, granulated T.N.T. 113.1, 60 per cent. straight dynamite 120.2, and blasting gelatine 149.8. At the other end of the scale is black blasting powder 10.5, with 40 per cent. gelatine dynamite 73, and the same percentage ammonia dynamite 75.5.

Summing up, T.N.T. has proved itself a very tame servant; the beast of war has become the burden bearer of peace. For shooting up boulders, digging ditches, removing stumps, splitting logs, and similar work it is fully as tractable, every bit as safe, and entirely as efficient as 40 per cent. straight dynamite. It gives complete detonation if properly handled, detonates as completely under water, and can stand moderate immersion in wet holes. It is less sensitive than the dynamite, and is therefore as safe or safer to handle.

And this, if you please, is T.N.T. the terrible!

Science is, I believe, nothing but trained and organized common sense differing from the latter only as a veteran may differ from a raw recruit; and its methods differ from those of common sense only so far as the guardsman's cut and thrust differ from the manner in which a savage wields his club.

—HUXLEY.

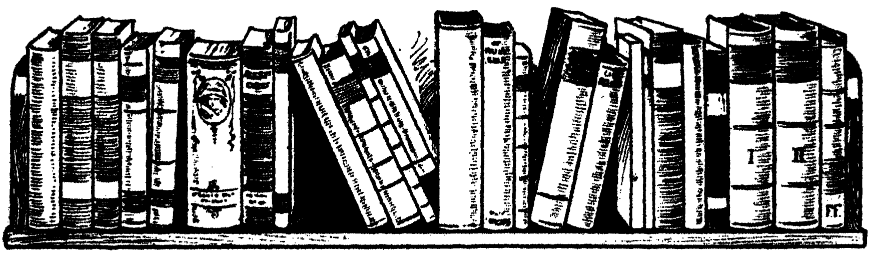
REVIEWS.

Insect Pests and Fungus Diseases, by P. J. Fryer, F.I.C., F.C.S., pages xv + 728. With numerous plates and illustrations. Cambridge University Press. Price £3. As the author in his prefatory remarks points out, practical workers in most scientific industries have a choice of several standard works of reference by well-recognised experts to guide them in their operations. In Great Britain, apparently, the fruit-grower has not had this assistance, and so Mr. Fryer's aim has been to make good this deficiency. So far as the British fruit-grower is concerned, he has attained his object. For the fruit-grower in Australia, however, conditions are so vastly different that much of the data contained in this volume will not be of material assistance to him. Many pests, both insect and fungoid, which inflict serious losses in other countries, are either unknown in Australia or, where existent, are of slight economic importance. Conversely, many insect and fungoid pests which cause great destruction in this country do very little damage in other countries. Notwithstanding the unavoidable limitations of Mr. Fryer's work, the volume will be of considerable value to fruit-growers the world over, because of the wide extent of general information it contains. The author is to be congratulated on the arrangement, as well as the treatment, of his subject. He opens with a section explaining in what manner trees are attacked by insects and fungi, and shows how the vitality of trees and shrubs is reduced. The next section explains how fruit trees live, and what exactly are the functions of the leaves, trunk, branches, roots, flowers, and fruit. Proceeding with these elementary but essential explanations, the author devotes another section to the life-history of insects, the changes which they undergo from the egg stage to the adult insect; and he includes a section descriptive of the broad classification of insects. By this means the fruit-grower is enabled to arrive at a proper understanding and appreciation of the problems with which he is faced, and how best to deal with them. The various stages of the metamorphosis of individual pests is also described and frequently illustrated, in some cases with coloured plates. A few notes on the distribution and life history of each are given. The economic importance of each pest is also indicated under a variety of headings such as "Trees Attacked," "Frequency of Pest," "Nature of Attack," "Degree of Damage," "Remedy," and "Calendar of Treatment." Insecticides are discussed at length, and clear and explicit directions are given regarding the preparation of spraying compounds. There is urgent need for a similar work dealing with insect and fungoid pests in Australia, and the entomologist who follows along the lines laid down by Mr. Fryer would deserve the grateful thanks of all those interested in fruit-growing in this country. A great deal of data has been published from time to time in various publications throughout the Commonwealth, but nothing so comprehensive and helpful as Mr. Fryer's work has yet been published in Australia. The fruit

industry is rapidly becoming of enormous importance to Australia, and the practical man needs all the assistance he can obtain from scientific workers to help him in his daily work.

Reports on Hides and Skins (Indian Trade Inquiry), by the Imperial Institute; John Murray, Albermarle-street, London.—The raw cow hides (kips) exported from India are normally of the value of about £4,000,000, and before the war were principally taken by Germany and Austria. Other outlets have necessarily to be found for them, and the reports outline the steps taken to attain this end. The trade in raw Indian cow hides is described, and other subjects dealt with are the improvement of the quality of Indian hides, the trade in Indian buffalo hides, the trade in Indian goat and sheep skins. A summary of general information prepared for the Committee is appended.

Reports on Oil Seeds (Indian Trade Inquiry), by the Imperial Institute; John Murray, Albermarle-street, London.—The publication contains a report on the trade in Indian oil seeds (with two appendices) and the Indian trade in oilseeds, together with a summary of general information prepared for the Committee.



SCIENCE AND INDUSTRY.

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Paper Manufacture in Australia.

IN the October number of this Journal, Mr. I. H. Boas, the officer in charge of the Forest Products Investigations, alluded to the experiments being carried out by the Institute into the paper-making qualities of Australian woods. An important point mentioned by him was that one of the largest paper companies in Canada was now using 15 per cent. of hardwood in its pulp for newsprint. Later information has been received that the proportion of hardwood pulp has been increased to 25 per cent. Compelled by the world-wide scarcity of softwoods, this company has, as the result of its experiments, exploded the fallacy that hardwoods could not be utilized, and has translated into commercial practice the discoveries of its laboratory.

This fact is of considerable interest to Australia. Mr. Boas stated that Australia had never made any serious attempt to supply her own needs in the way of paper. Yet, although the possibilities of such a development have never been explored, it is generally accepted that large-scale utilization of our hardwoods for paper-making is too stupid even to contemplate. It is well within the memory of the present generation when the idea of growing wheat for export in New South Wales was ridiculed. Nature had intended that country as a sheep and cattle run, and such it ought to remain. Almost every development,

either of primary or secondary production, in Australia has been undertaken against the strongest opposition—an opposition based largely upon technical ignorance, or lack of confidence in the people and in the country. When the manufacture of steel was suggested, it was thought that the height of absurdity had been reached. To suggest an inquiry into the practicability of making paper in Australia from Australian timbers therefore involves grave risks.

Laboratory experiments carried out by the Institute encourage the belief, however, that satisfactory results can be obtained from the use of hardwoods. If these experiments are confirmed by experiments on a larger scale, the way to the establishment of a new and important local industry will be opened up. There are now good prospects of this intermediate step being taken. It is estimated that a sum of £10,000 will be required for the purchase and erection of the necessary plant to permit of the laboratory results being interpreted on a commercial basis. The Minister for Trade and Customs (the Hon. W. Massy Greene) has promised to make £4,000 available for this purpose if the remaining sum is contributed by persons interested in the establishment of the industry. The Forestry Commissions of New South Wales and Victoria also have each agreed to donate £1,000 towards the work. Requests, accordingly, have been addressed to various private firms for small contributions, and it is anticipated that the full amount will shortly be obtained.

One of the objections frequently raised against experimental work in the past (and its echoes are still heard) is that, even should pulp of sufficiently good quality be obtained, our forest resources are utterly inadequate to provide continuous supplies of raw material. Forestry experts do not share this misgiving. Several experts competent to express an opinion upon this point unhesitatingly affirm that supplies of timber can be readily obtained.

Mr. Boas has pointed out that it is too soon yet to state definitely what the economic possibilities are; but it is safe to say, from results obtained, that if a mill were to be erected to work on imported pulp, there is no doubt that, at the commencement, it would use a fair proportion of local pulp, and as further knowledge is obtained, this proportion could be largely increased. It would, moreover, make use of much timber now wasted, and enable the Forest Departments to more economically manage the forests.

EDITORIAL

BAUXITE DEPOSITS IN AUSTRALIA.

In view of the fact that bauxite is the chief source for the manufacture of aluminium, considerable interest is attached to a report issued by Mr. A. Gibb Maitland, Geological Survey Department of Western Australia, on the bauxite deposits of that State. Owing to the very great extent of those residual deposits for which the term "laterite" has been officially adopted, Western Australia possesses an asset of great value. Some of these lateritic deposits have been utilized in the past as a source of iron ore for fluxing purposes. Some of the laterites have been proved to be highly aluminous, approaching very closely in composition the bauxites of Europe, America, and India. So far, the most extensive aluminous deposit yet known in Western Australia is that which caps the Darling Range, and is situated in close proximity to railway lines connecting with the metropolis, hence no serious difficulties arise in connexion with transport should the exploitation of the deposits be undertaken at any time.

The analyses of the Darling Range laterites show that they can be grouped as follows:—

Acid soluble, Al_2O_3, under 35 per cent.	..	20
" " " from 35-40 per cent.	..	15
" " " from 40-45 per cent.	..	6
" " " from 45-50 per cent.	..	5
		46

Mr. Simpson states that the working of the laterite deposits would present no serious difficulty, and that it appears that what is known as the "Serpet Process" renders the utilization of some of the aluminous laterite deposits quite possible. By this process, bauxite and coal are heated in an electric furnace with the production of aluminium nitride; this being treated with a solution of caustic soda forms sodium aluminate and ammonia. The alumina is extracted from the aluminate in the usual way, and the ammonia converted into the valuable manure, ammonium sulphate. Mr. Simpson states that the deposits might be developed by—

(*a*) exporting the raw material for use in alumina factories,

(*b*) manufacturing pure alumina locally for export to aluminium works, or

(*c*) manufacturing the metal in the State.

The local manufacture of pure alumina would, on the whole, seem to be the one most practicable, and need not involve any very heavy capital expenditure. Aluminium being producible from bauxite by means of the electric furnace, it naturally suggests itself as to whether the coals of the Collie Field could not be utilized for the production of the electric power necessary for this and any other allied purpose.

INDUSTRIAL OXYGEN RESEARCH IN UNITED STATES OF AMERICA.

As the result of a gift of £1,000 by the Research Corporation, of which Dr. Frederick G. Cottrell, Director of the Bureau of Mines, is the founder, and Elon H. Hooker the president, research work is to be undertaken by the Harvard Engineering School, under the direction of Professor H. K. Davis, in the manufacture and industrial uses of oxygen. In consideration of its financial support, any patents ensuing from the research will become the property of the Research Corporation. Dr. Cottrell estimates the production of oxygen in the United States at 3,000,000 cubic feet, or about 130 tons, over 95 per cent. of which probably is used for cutting and welding purposes. The Linde Air Products Co., using the Linde process and operating about 50 liquefaction plants, and the Air Reduction Co., using chiefly the Claude process, produce about 75 per cent. of the oxygen consumed, which they compress in steel cylinders and distribute to the trade. The remaining 25 per cent. is obtained by electrolysis in several hundred privately-owned installations producing gas for immediate industrial consumption in the plant. At Muscle Shoals, Nitrate Plant No. 2, were installed 30 of the largest-size Claude units, primarily for the separation of nitrogen used in the production of cyanamide. If this installation, it is stated, were used for oxygen production, the daily output would about equal the total oxygen production noted above. The great economic importance of oxygen research, and the value of increased knowledge of cheap and efficient methods of separation of this gas, particularly to the metallurgical industries, will be recognised by the fact that a single-blast furnace, with a daily production of 500 tons of pig-iron, requires to have blown into it for this yield a volume of air containing five times the oxygen produced daily by present methods and resources.

BAHIA GRASS.*

A large number of species of Paspalum are native to Florida. These are generally known as blanket grass or water grass, but sometimes as goose grass. In addition, several valuable species have been introduced from South America, including Dallis grass (*Paspalum dilatatum*), Vasey grass (*Paspalum larranyagai*), and, lastly, the species here discussed, *Paspalum notatum*, native in South America and northward to Mexico, for which the Bureau of Plant Industry suggests the name of Bahia grass. It gives most promise as a pasture grass. This was introduced into the United States, in 1913, by the Bureau of Plant Industry. Another introduction was made in 1914.

* Florida Agricultural Experiment Station, Gainesville, Fla.

EDITORIAL.

Bahia grass was first planted at the Florida Agricultural Experiment Station in May, 1913. The original plot is still growing. From the very first, this grass gave promise of being valuable.

On 31st March, 1915, a plat of Bahia grass was planted in the pasture on the Experiment Station Farm. The ground was ploughed and a good seed bed prepared. Plants were taken from the original seed bed and set out in rows 24 inches wide, with the plants 24 inches apart in the row. Two rows, each about 200 feet long, were planted. The plat was fenced to keep off the stock. The grass made a good growth the first summer, and a good crop of seed was produced the first season. The latter part of September, 1915, the fence was removed, and cattle have pastured on it, both winter and summer, since that time. During the past four years the grass has been subjected to heavy pasturing. Notwithstanding this fact, it has continued to grow, and has made a complete sod over a space now 10 to 12 feet wide. In addition to this, a large number of individual plants have sprung up adjacent to the planting, indicating that the seed has been scattered by the cattle, birds, or wind.

This is, we believe, a new method of testing the value of a grass for pasture. A grass to be of value for pasture should, in addition to being nutritious, have good staying qualities. That is, it must stand hard and close pasturing under all conditions. A grass that needs to be nursed and coaxed after it is once established is not desirable for pasture purposes.

The method here employed gives information on two important points, namely, the ability of the grass to spread and make a good sod while being pastured, and its palatability to cattle. The results of this test show that Bahia grass will spread and make a complete sod under pasture conditions. It has also shown that cattle like this grass, as they graze on it at all seasons of the year.

Bahia grass seems best adapted to a rather moist soil. This does not necessarily mean a low, poorly-drained soil, but rather one that holds moisture well. However, it has been grown on rather dry sandy soil on the Experiment Station grounds with fairly satisfactory results. It is not likely to be of any value when planted on dry sandy ridges. Neither is it likely to be a success when grown on land that is subject to overflow, especially where the water stands for several days. The original seed plat and the plat in the pasture are both on land which is ordinarily considered first class farm soil in Florida.

Bahia grass is rather sensitive to cold. A temperature of 34 to 26 degrees will nearly always kill all green growth of this grass. The roots apparently are not injured by frost or light freezes. When moisture conditions are favorable, growth starts in the spring, about the same time as other perennial grasses.

No commercial seed of this grass is yet available, but efforts are being made to establish a supply. It seeds freely in Florida when not pastured. When once established, it should not be a difficult matter to gather the seed for additional planting.

HOW TUBERCULOSIS SPREADS AMONG CATTLE AND PIGS.

The extent to which bovine tuberculosis, if uncontrolled, runs its course through a herd of cattle is shown in a recent report received by the United States Department of Agriculture from one of its field inspectors in Illinois, and published in the *Weekly News Letter.* Every animal in a herd of grade Holsteins and Jerseys re-acted to the tuberculin test. The herd consisted of 14 cows, 2 calves, and 2 bulls. Upon *post-mortem* examination, six of the animals showed such extensive lesions that the entire carcass was condemned and destroyed. All of the other re-actors likewise showed lesions, though not of such an extensive nature as to necessitate destruction of the carcass. The fact that every animal in the herd re-acted and showed lesions makes the case one of the most striking ever recorded. The danger of tuberculous cattle to swine was further demonstrated by the sale of hogs from this farm early in the year. The first lot of 21 hogs sold showed such extensive lesions of tuberculosis upon *post-mortem* that the packing company refused to accept the remaining 50. These were subsequently sold to a local shipper, and their identity and destination are not known. If the swine are still alive, they are undoubtedly a menace to other stock. The Bureau of Animal Industry cautions swine-owners against purchasing stock from farms where either tuberculous cattle or swine are kept. The Bureau inspector also reported that, a week after the shipment of hogs had been made, a milch cow—a chronic cougher—had died, and the younger stock was allowed to devour the carcass. Such a practice is responsible for a great deal of tuberculosis among swine in the United States. According to Bureau officials, the facts stated should cause any live-stock farmer who finds tuberculosis among his hogs, or whose shipments of hogs are refused because of extensive lesions of that disease, to have his herd of cattle tested promptly. Unless the origin of infection is known and removed, tuberculosis is liable to run its course among all the cattle and swine on the farm.

INDIAN MANGO.

The East Indian mango, states the *Weekly News Letter*, is one of the great fruits of the world. To those who have really tasted the good sorts of it, the peach loses its place of highest honour. But the early travellers were more interested in describing its peculiarities than in extolling its wonderful fragrance and the depth of its flavours, for they told the plum and cherry eating inhabitants of the British Isles that the mango resembled a ball of tow soaked in turpentine and molasses, and said, further, that in order to eat it you must undress and climb into a bathtub, and that, after you ate it, you must comb its yellow hair-like fibres out of your teeth. No other fruit in the world has been so maligned. The mango trees, which are now loaded with their golden fruits in South Florida, are so valuable that the mayors of the towns of South Florida are being beseeched to keep the boys from stealing the fruit from the trees, not because they are balls of tow soaked in molasses and turpentine, but because, as they hang on the tree, they are worth 25 or more cents apiece, and a boy can eat up a 5 dollar bill's worth in the time it takes to tell about it. The Office of Foreign Seed

and Plant Introduction of the United States Department of Agriculture has assembled, through the work of its explorers, and through exchange with the British East Indian Departments of Agriculture, one of the largest collections of selected mango varieties in the world. There are now fruiting at the Plant Introduction Field Station, Miami, Fla., about twenty varieties this year, and these represent the selections from more than 70 sorts of this great fruit. Some of these have scarcely more fibre on them than a free-stone peach, and can be cut open lengthwise and eaten as easily with a spoon as a Rocky Ford cantaloupe. They have an indescribably agreeable aroma, reminiscent of pineapples. The mango tree, when it is in bearing, is a gorgeous sight, for it is a large long-lived tree, and the golden-yellow fruits, as they hang in great clusters from the dark-green foliage, make one of the great tropical plant sights of the world.

RICE EXPORTS TO JAPAN SHOW INCREASE FOR FIRST QUARTER.

The United States exported more than 300,000 lbs. of rice to Japan during the first three months of this year, according to figures of the Bureau of Markets, United States Department of Agriculture. In contrast, less than 1,000 lbs. of this commodity were exported to Japan during the entire year of 1919. The average rice exports of the United States to all countries during the period 1910-14 were less than 20,000,000 lbs. a year. To-day, the exports range from 30,000,000 to 60,000,000 lbs. a month. This enormous export business has been made possible by the development of the rice industry in California, based upon experiments made by Department of Agriculture scientists in growing rice in communities where it was said to be impossible to grow this commodity. The first commercial field of rice in California was planted in the Sacramento Valley in 1912. There are now a dozen rice mills in operation in this State, which handled £4,000,000 worth of rice last year. There is an almost unlimited opportunity for future development of this industry in the United States, say the Department's specialists. The rice-growers are most enthusiastic over the outlook, and declare that they are going "to teach the American people that rice is one of the finest foods in the world."

IMPROVED MINE-RESCUE METHODS AND APPARATUS.

The Mine-rescue Apparatus Research Committee of the Department of Scientific and Industrial Research have presented their second report to the Advisory Council of the Department, on whose recommendation it has now been published. The work described in the report relates chiefly to experimental results obtained during the last two years since the publication of the Committee's first report, and to the description of new or improved mine-rescue methods and apparatus which are the outcome of the investigation. The report is divided into four parts:—I. Physiological considerations and experiments; II. Deaths due to rescue apparatus; III. Approval of mine-rescue apparatus; IV. Miscellaneous; and two appendices are included—I. The

Briggs' compressed oxygen mine-rescue apparatus; II. Fitness testing with the ergometer. Copies of both the first and second report of the Committee (price—1s. 9d., by post 1s. 11d.; and 2s., by post 2s. 2d., respectively) may be obtained directly from H.M. Stationery Office.

INDUSTRIAL FATIGUE.

The first annual report of the Industrial Fatigue Research Board (H.M. Stationery Office) contains an interesting record of work completed or in progress. Of the four reports already issued, that of Dr. Vernon, dealing with the influence of hours of work and ventilation on output in the tin-plate industry, is the most extensive, while the report by Mr. Major Greenwood and Miss Hilda Woods, upon the incidence of industrial accidents (the statistical theory of this investigation has been further developed in a paper by Messrs. Greenwood and Yule, published in March, 1920, issue of the *Journal of the Royal Statistical Society*) suggested some important problems which the Board proposes to study further. Mrs. Osborne's paper on the output of female munition workers, and Dr. C. S. Myer's analysis of the results obtained in a factory after the introduction of motion study, are also of interest. Amongst investigations not yet completed, that on the relation between length of shift and fatigue in the iron and steel industry, intrusted to Dr. H. M. Vernon, is almost ready for publication, and progress has been made with inquiries into special conditions affecting the cotton, boot and shoe, and silk industries. The Board has a large number of tasks in hand, and it is yet too early to decide which are likely to be most remunerative. It is, however, clear that careful thought has been devoted to the organization of research, and we have no doubt that the outcome will be of the greatest benefit to both employers and employed.

SANDALWOOD OIL.

The sandalwood industry in Western Australia forms the subject of a note in a recent issue of the *Times* Trade Supplement. It is much to be regretted that, in season and out of season, attempts are made to persuade those who do not know to the contrary that the difference between the true sandalwood oil of the British Pharmacopœia and the Western Australian oil of the same name is merely an academic one. In the note in question it is stated that one species of Santalum growing in the State has yielded an oil similar in most respects to Mysore oil, but with an average rotation of 2 degrees. Investigation, it is claimed, has, at all events, shown that the lowest quality of refined Western Australian oil is equal, medicinally and therapeutically, to the Mysore oil. This claim, it is suggested, cannot be substantiated, and would mean that 70 per cent. of the alcohol, whatever it may be, present in Western Australian oil is as active, medicinally, as 90 per cent. or more of true santalol present in the Indian oil. The real facts are, it is stated, as follows:—The Western Australian oil is distilled from a species of Santalum which yields a quite different oil from that of *Santalum*

album, from which the official oil in the British Pharmacopœia is obtained. Its characters and composition are quite different from those of the official oil. It has been well known since about 1875, and repeated attempts have been made to popularize it. It is not legal to sell it in this country as medicinal sandalwood oil, and the only proper method of dealing with it is to get experts to make therapeutic tests. and, if successful, to approach the General Medical Council and try to persuade them to recognise the oil officially.

[The Institute of Science and Industry has already taken steps to ascertain the chemical and therapeutic qualities of Australian sandalwood oil with a view to its inclusion in the B.P.—Ed. *Sc. & Ind.*]

FORESTRY EDUCATION.

The British Empire Forestry Conference, which met in London during July, adopted the following resolutions on forestry education, which the delegates are to bring to the notice of their respective Governments:—It should be a primary duty of forest authorities throughout the Empire to establish systematic schemes of forest education. It has been found, for climatic and other reasons, that it would not be possible for each part of the Empire to establish a complete scheme of forestry education of its own, and therefore it is essential that those parts of the Empire which are willing and able to establish complete systems should, as far as possible, frame such schemes with a view to combining for meeting the needs of those parts which can only themselves make a partial provision for their requirements. Part of this subject has been dealt with by a Committee, whose report, which refers mainly to the higher training of forest officers, is approved by the Conference. The main principles embodied in this report are as follows:—1. That one institution for training forest officers be established in the United Kingdom. 2. That students be selected from graduates having taken honours in pure or natural science at any recognised University. 3. That it be an integral part of the work of the institution to arrange supplementary courses at suitable centres for students requiring special qualifications and also special courses for forest officers from any part of the Empire, whether at the institution or at centres of training in other parts of the world. The Governments should recognise these courses as part of the ordinary duties of the forest officers at any time during their service, and the Governments concerned should give special facilities to forest officers in their service to attend such courses. 4. That a Department of Research into the formation, tending, and protection of forests be associated with the training institution. 5. That encouragement should be given to the existing provision made by universities and colleges for forestry instruction for those who do not desire to take the full course suggested for the forestry service. It appears that this is especially applicable to the United Kingdom. It is also desirable to make adequate provision for woodmen's schools for the training of foresters as distinct from those which are intended for forest officers.

NORTH AMERICAN FOREST RESEARCH.

The National Research Council reports that it has published a complete summary of all of the scientific investigations upon forest problems which are now under way in the United States and in Canada as a bulletin upon "North American Forest Research." This bulletin was compiled by a Committee of the Society of American Foresters composed of:—Earl H. Clapp, Assistant Forester U.S. Forest Service; Clyde Leavitt, Commissioner of Conservation of Canada, Ottawa; Walter Mulford, Professor of Forestry, University of California; J. W. Toumey, Director of the Forest School, Yale University; E. A. Ziegler, Director, State Forest Academy, Mount Alto, Penn. In this bulletin 519 different projects for investigation are described, including the reforestation of cut-over areas, the replacement of timber cuttings by natural growth, the control of insect pests and fungus diseases of forest trees, beneficial modifications of lumbering practice, the preservation of timber in use, the utilization of by-products, and the relation of forestry to rainfall, control of flood waters, grazing, &c. The importance of the most penetrating study upon the conservation of our remaining forest resources is brought home by the recent announcement of the Forest Service that "three-fifths of the original timber of the United States is gone, and that we are using timber four times as fast as we are growing it." The annual consumption in U.S.A. of lumber alone is over 300 board feet *per capita*, and of newsprint is 33 pounds *per capita*. Cut and burnt-over forest lands in the United States, now waste territory, equal in area the whole of the present standing forests of Denmark, Germany, Holland, Belgium, France, Switzerland, Spain, and Portugal. The total population of these countries is about 152,200,000, nearly 50 per cent. greater than the population of the United States.

INSECT PESTS.

In connexion with tropical agriculture, attention has been directed to the question of the influence of the condition of the host-plant on infestation with sucking insects. It is believed that such pests as thrips on cacao and froghopper blight on sugar-cane can be held in check by increasing the resistance of the plant by improving agricultural conditions. In the *Agricultural News* (vol. XIX., No. 464), it is claimed that the "mosquito blight" of tea (caused by a capsid bug of the genus *Helopeltis*) is affected in a similar way, and that the condition of individual tea-bushes determines the susceptibility to attack. The distribution of mosquito blight appears to be connected with soil conditions, and analytical data indicate that soils on which the pest is prevalent show similarities in the potash-phosphoric acid ratio, the addition of potash having an appreciable, though irregular, action in reducing the blight. Water-logging tends to encourage infestation, probably because the vitality of bushes grown on such areas is lowered; draining is the remedy advised in such cases. Acidity and poverty of soil are other factors which vitiate the health of the tea-bushes, so rendering them more liable to attack.

EDITORIAL.

The loss caused by the jointworm flies of the genus *Harmolita* (*Isosoma*) in the United States runs into millions of dollars per annum, the wheat jointworm (*H. tritici*) being the greatest devastator. W. J. Phillips (Bulletin 808, Professional Paper U.S.A. Department of Agriculture) has gathered together the available information and classified the species into groups that attack grain crops, cultivated grasses, and wild grasses. The two first groups cause considerable loss by the injury they entail to the crops. The members of the last group, however, may possibly be beneficial in an economic sense, as they provide intermediate hosts for the parasitic insects which prey upon the genus, the more important parasites being common to the majority of species of *Harmolita*. The life-histories of several species are described, together with the way in which injury is caused to the plants attacked. *H. tritici* causes the most serious losses, reducing the yield of wheat by as much as 50 per cent., the grains being somewhat small and shrivelled. *H. grandis* is also confined to wheat, and produces two generations in the year, but as it is easily controlled its powers of destruction can be kept in check. Breeding experiments indicate that each species is probably confined to a single host, as it has proved impossible to induce the more important forms to attack other crops than that with which they are normally associated. The jointworms are much subject to parasitic attacks, and for this reason do not often get quite out of hand and destroy an entire crop; but, even so, they exact a toll of from 1 to 5 bushels per acre unless control measures are adopted. Experiments seem to show that ploughing under the stubble is the most effective remedy, as wholesale destruction of the insects is thus brought about. It would be necessary to arrange the crop rotation so as to allow the wheat-stubble to be ploughed up, but if this could be done it is estimated that millions of dollars could be saved yearly.

Parasites such as lice and mites cause considerable loss in the poultry industry by reducing egg-production and injuring the quantity and quality of the flesh of the birds. A cheap but effective remedy is therefore much to be desired, and it is now claimed by F. C. Bishop and H. P. Wood (Farmers' Bulletin 801, U.S.A. Dept. Agric.) that sodium fluoride fulfils these conditions, and that, if properly used, one application will completely destroy all the lice present on any bird. The treatment can be carried out by dusting or by dipping. In the former case, pinches of the fluoride are placed among the feathers close to the skin on the parts most frequently attacked; dusting with a shaker is less effective, and also caused more irritation to the nose and throat of the operator. In the latter case, $\frac{3}{4}$-1 of commercial sodium fluoride is dissolved in a gallon of tepid water, and the birds are then dipped for a few seconds. The lice die more rapidly in this case than when the dry powder is used. It is estimated that the cost of treatment works out to about one farthing per bird, 1 lb. of sodium fluoride sufficing for about 100 hens.—(*Nature*, 22nd July, 1920.)

The Relation of Insects to the Dissemination of Diseases.

By EWEN MACKINNON, B.A., B.Sc.

The subject of entomology in its relation to the transmission of diseases by insects, or, as we might call it, the entomology of disease, has been placed on a firm footing by the investigations carried out during the great war. By the co-operation of entomologists, parasitologists, doctors, chemists, sanatarians, engineers, and others, many problems affecting the health of large armies have been satisfactorily solved. Everything had to be handled on an enormous scale; materials and methods had to be standardized and made available for millions. Such problems as the control of the louse, the bug, the fly, and the mosquito have led to the introduction of numerous types of latrines, incinerators, sterilizers, steam disinfectors, and oil distributors. The subject of insect repellants was studied very thoroughly, and many new chemicals were made and tested. Probably the greatest advances were made with the investigations on the louse and bug problems, and resulted in proving that such diseases as typhus, relapsing and trench fevers, were transmitted by the louse and the bed bug, but not by biting, as has been almost universally assumed. The infection is caused by the louse or bug being scratched into the flesh, or by having their feces scratched in. They breed in filth, and are to be controlled by cleanliness, heat, water, and chemicals. This involved the sterilization of all clothing, and the bathing of whole armies. Steam sterilization experiments led to investigations on the shrinking of woollens, the bactericidal effect of each process in the laundry; also the effectiveness of very many chemicals as insecticides, and as impregnating substances, the duration of effectiveness and the effects on skin and clothing. The results achieved with the louse and bug have given indications of why many experiments in the past on the transmission of disease by insects have failed. It is of interest, therefore, to consider the ways in which insects transmit disease. The principles are very much the same in plant or animal pathology, and the technique is similar. In fact, in the relation of bacteria to plant diseases, the whole of the procedure has developed from animal pathology, and Koch's rules for the proof of the parasitism of an organism are followed by the plant pathologist. An important point to remember is that the healthy plant cell and the plant sap, like the human blood, are all in their normal condition free from living organisms. Pasteur was the first to show this when he proved by culture experiments that grape juice taken from the interior of sound berries was free from micro-organisms. Chamberland also, in 1880, working in Pasteur's laboratory, showed that beans taken directly from the interior of their pods were free from bacteria. It was Burrill (U.S.A., 1878-1883) and Wakker (Netherlands, 1883) who first proved satisfactorily by cultures and inoculations that bacteria cause plant diseases. Burrill determined the cause of pear blight to be a bacillus which is now known as *Bacillus amylovorus*, and Wakker

discovered the cause of the yellow disease of hyacinths (*Pseudomonas hyacinthi*). But it was later investigators like J. C. Arthur, M. B. Waite, and, above all, Erwin Smith, who established the sure foundations of the science of bacteriology as related to plant diseases. Many of the Germans who were well advanced in the study of diseases due to fungi were opposed to the idea that bacteria could possibly cause diseases in plants, and as late as 1900 R. Hartig, Alfred Fischer, C. Wehmer, and others were still writing against such a cause. Other German writers, such as Flugge (1896), in his book on *Micro-organisms,* 1,385 pp., and Frank (1898), in *Plant Diseases*. 1,213 pp., dismiss the subject of bacteria as the cause of plant diseases in three and thirteen pages respectively. Sorauer, however, as early as 1886, accepted the doctrine of bacterial diseases of plants, without reserve. Migula also, in the first volume of his *System* (1897), mentions twenty-nine such diseases, and considered that eight were of proved bacterial origin; and in his second volume, in which 1,350 species of bacteria are described, gave 30 that are of interest to the plant pathologist. Very little was mentioned by English writers twenty years ago. In 1899 and 1901, Massee and Marshall Ward, recognised authorities and writers on diseases of plants, only briefly mention the subject in a few pages. One of the chief reasons for believing that bacteria could not cause diseases in plants was the fact that cell sap is practically always acid, and it was thought that this was inimical to the growth of bacteria, which, bacteriologists thought, required an alkaline or at most a neutral medium for their development. It has taken a vast amount of exacting scientific work to show that bacteria are responsible for many destructive diseases of plants, and we might say that plant bacteriology as a science is the development of the last twenty years. It is not to be wondered at, therefore, that the active part taken by insects in the dissemination of such diseases is little known, as many of the diseases themselves have only quite recently been determined. With respect to investigations on human and stock diseases, and the nature of the secondary host, European workers are as active as Americans, but in the domain of plant diseases and their distribution, we find that the greatest amount of work has been accomplished in the United States of America, and we are indebted to such authors as Erwin Smith, F. Rand, and W. Dwight Pierce. We have to beware of accepting American results as being applicable in Australia, where climatic and ecological factors in controlling insect distribution may be very different. We shall have to work out our own problems of insect development and control, the relative limits of egg production, the number of generations in a year, the periodicity of insect appearance, and the factors that bring it about, the relation of insect to host plant, and the manner in which insects are involved in the transmission of diseases. Let us turn, then, to the question of the general relations of insects (including also the Acarina) to parasitic diseases.

The functions of a plant or of an animal may be disturbed directly by an insect without the intervention of any parasitic organism. A well-known example is the so-called "tick worry" of cattle in Queensland. The mere presence of large numbers of ticks causes some fever. In plants, a condition long known as melanose of the orange in New South

Wales was at one time attributed to the presence of mites. Other causes meet with more favour now. In the case of the vine, however, erinose is due to the presence of the mite *Phytoptus* (*Eriophyes*) *vitis*, and a similar condition occurs on pear leaves. The relations which insects may bear towards diseases due to micro-organisms may be stated as follows:—

I. Mechanically Carried (External Transmission).

The infective organism may be picked up by the insect on external parts of its body, *e.g.*, legs, or outer mouth parts, where it may retain its virulence for some time.

(*a*) The organism may then be directly inoculated, as into wounds made by the insect carrier; or

(*b*) the organism may be accidentally sown from the insect's body under such conditions that infection follows.

II. Actively Carried (Internal Transmission).

The micro-organism may be taken up by an insect during feeding, and passed along unharmed in the alimentary tract.

(*c*) If the infective principle is merely taken into the body, and without change or multiplication passed out in the normal way, we have *Mechanical internal transmission.*

(*d*) If the infective principle develops or multiplies within the insect body, and finally reaches a part from which it may be successfully transferred to its alternate host, we have *Biological internal transmission.*

III.—Indirect Association.

An insect, though not itself carrying infection, may cause wounds, through which parasitic micro-organisms, brought there by other agencies, find easy access into the plant or animal body.

I. Mechanically Carried.

(*a*) *Directly Inoculated.*

The mechanical external carriage and inoculation of pathogenic organisms by insects is very common among animals and plants. Fire Blight of the apple and pear, caused by *Bacillus amylovorus,* was the first plant disease shown to be bacterial in nature, by Burrill in 1880. Waite also demonstrated clearly that bees and other insects carried the bacillus from flower to flower. He proved experimentally that they carry the disease organisms, which multiplied in the nectar of the flowers. Wasps and ants also spread the disease. Waite observed 40 species of insects visiting pear blossoms, and many were proved experimentally to be carriers. *B. amylovorus* was repeatedly isolated from the mouth parts of bees. Direct insect relation was clearly proved, and insects not only disseminate the disease germs, but also actively puncture the tissues, and so introduce the disease. Other insects concerned are aphids, leaf-hoppers, bark-boring beetles (*e.g.*, Scolytus), and a plant bug (Lygus). The germs may remain viable for many days in honey and in honey-dew of aphids. The wilt of Solanaceous plants due to *Bacterium solanacearum* was experimentally transmitted by Erwin

Smith, using the Colorado Potato Beetle. We have not yet found the Apple and Pear Blight in Australia, but the Potato Wilt (*B. solanacearum*) and the cabbage Black Rot (due to *Bm. campestre*) occur here. The latter has been proved to be transmitted by various plant bugs, beetles, aphids, and insect larvæ, that feed on cruciferous plants.

Among diseases of animals, some of the parasitic Trypanosomes are mechanically carried by blood-sucking insects, and transferred directly to vertebrate hosts without having undergone any change.

Fungous Diseases.—The Brown Rot of stone fruits (Sclerotinia) is spread by wasps, soldier bugs, and other insects puncturing fruit. Sucking insects of the squash bug family (Coreidæ) are known to puncture fruit, and so pick up and distribute the spores of the fungus. The Black Spot of cabbage (*Phoma oleracea*) is commonly disseminated through injuries caused by wire worms. A disease which Massee states has been spread greatly in England by the Woolly Aphis (*Schizoneura lanigera*) is the *Nectria ditissima* canker on apple trees. He goes so far as to say that had there been no woolly aphis there might not have been any canker. Our experience is somewhat different. We have any quantity of woolly aphis in Australia, but as yet there is no record of the *Nectria* disease, though several other cankers are known. *Nectria* occurs in New Zealand.

In the case of anthracnose of sweet peas, circumstantial evidence points to aphids and red spiders as common distributors of this disease. In some parts of New South Wales, *Colletotrichum* on garden peas has been disastrous to the crops, but these epidemics have not been materially widened by insect transmission.

I. Mechanically Carried.

(*b*) *Accidental Infection without Direct Inoculation.*

The insect is a mechanical carrier only, and the infective organism is not directly inoculated, but is accidentally sown from the insect's body.

Bacterial.—In human diseases, house flies are common agents of dissemination in this manner. Their legs and body are hairy and well adapted for mechanical carriage of bacteria which they pick up when they come in contact with infected material. Outbreaks of typhoid and cholera have frequently been traced to flies as the active agents.

Similarly in plant diseases, various flies often carry the sap of diseased pomaceous trees after pruning, and spread *B. amylovorus* to healthy trees. Ants act in a similar way. Hail-marks form entrance points for infection.

Walnut Blight occurs in several localities in Australia, and is apparently spreading. In California, R. E. Smith isolated the causal organism *Pseudomonas juglandis* from the bodies of flies, which had been attracted by the exuding organic matter.

Fungous Diseases.—Many rust spores are carried by insects which are attracted by the bright colour, odour, and exuding sweet fluids at various stages of development. Johnson, in United States of America, working on floret sterlity of wheat, found thrips were often numerous

and active in distributing spores. The presence of rust spores between the glumes of wheat florets could thus be accounted for. Ludwig called attention to the interesting fact that smut spores, which have a roughened cell wall, are found in those parts of their host which are regularly visited by insects, while the smooth-spored species occur on wind-pollinated plants, or on parts that are not regularly visited by insects.

Species of fruit flies distribute the spores of the Bitter Rot of pome fruits caused by *Glomerella cingulata*. Although the washing and dashing about of the potato plant by rain and wind are the most active means of spreading Late Blight (*Phytophthora infestans*), insects, especially beetles, carry the spores greater distances.

II. Internal Transmission.

(*c*) *Mechanical.* (*d*) *Biological.*

The parasitic organism (*c*) may pass passively through the insect, or (*d*) may remain and multiply within the body. In the first case, there may be overlapping with the mechanically carried condition, as many organisms may be both externally carried and internally mechanically transmitted, passing into the digestive system with the food of the insect. The organism may leave the body by two ways. Very many insects are provided with a storage sac or crop, and such insects commonly regurgitate some of its contents, either as a result of overfeeding, or to moisten the food they are about to ingest. Ants regurgitate their food to feed their young. It is a well known dirty habit of the house fly that it vomits on its food before feeding, and these vomit spots invariably contain infective germs. Graham Smith found that house flies (*Musca domestica*) defecated from three to eleven times per hour, and vomited from six to fifteen times an hour, the rate depending on the temperature and food. They are attracted equally by food and by filth, and this commingling of tastes leads to the spread by flies of such diseases as typhoid, dysentery, infantile and summer diarrhœas, tuberculosis, ophthalmia, cholera, &c. People in Australia are far too indifferent to the dangers from house flies, and too little care is taken to prevent their access to latrines, feces, garbage, and other sources of infection. Very seldom do we find sufficient protection for all food in the house, especially milk (and cups) used for feeding children. Flies have been well named by Hewitt "The sanitarian's red lamps," indicating danger from the presence of filth, and also the "Potential destroyers of human life."

The transmission of the bubonic plague organism (*Bacillus pestis*) by fleas is probably well known to most people, although there has not been an outbreak in Australia for many years past. Plague bacilli have been found in the intestines of fleas, in some cases three weeks after ingestion, but it has not been shown that any multiplication takes place. They are inoculated by the flea-bite, or by scratching parts of the bodies or feces of infected fleas into the skin.

Among Fungi the well-known "Stink Horns" (*Ithyphallus spp.*) attract insects, especially flies. So powerful is the attraction that it is sometimes almost impossible to hunt the flies away. Ants also carry the spores under ground to their nests, and, no doubt, the fungi find

conditions favorable for their development. Ergot (*Claviceps purpurea*), which is now found on many cereals and grasses in New South Wales, exudes a glistening saccharine liquid very attractive to flies, which carry the spores both on their body and internally, depositing viable spores in their feces. A disease that does not yet occur in Australia, Peanut Leafspot, due to *Cercospora personata,* has been widely spread in the United States of America by grasshoppers. One of the commonest diseases of the tomato is Early Blight (*Alternaria solani*), and the spores of this, in addition to those of the other common leaf blight (*Septoria lycopersici*), have been found in the excreta and on the bodies of the larvæ and adults of the Colorado Potato Beetle (*Leptinotarsa*), and the tomato worm (*Protoparce*) by American investigators, and no doubt these two common diseases here are widely spread by beetles, aphids, and worms. Flea beetles (*Epitrix*) are also active distributors.

II. (*d*) *Biological Internal Transmission.*

In this method, the infective principle persists within the insect, and undergoes multiplication or some further stage of development. Many of these processes are complicated and difficult to investigate. They include diseases due to Protozoa, filterable viruses, bacteria, and fungi. Of the Protozoan diseases, malaria is one of the best known. Our health authorities are somewhat concerned about the possible spread of the disease in Australia. We have both the source of infection—many returned soldiers who are still suffering from the presence of the parasite in their blood—and the transmitter of the disease, the *Anopheline* mosquito (not yet recorded as infected in Australia), in whose digestive parts the *Plasmodium* can pass through its sexual development. Should one of these mosquitoes become infected by sucking the blood from an infected person, the parasite (*Plasmodium malariæ*) will go through certain stages of its life cycle, and may then infect any healthy person whom the mosquito bites. Somewhat similar diseases are The Sleeping Sickness of man caused by two or more species of Typanosomes, *T. rhodesiense* in South Central Africa, transmitted by the fly *Glossina morsitans* and *T. gambiense*, less virulent than the former and more generally distributed by the fly (tsetse) *Glossina palpalis.*

African Relapsing Fever is caused by a Spirochæte (*S. duttoni*), and the transmission is through the bite of an argasine tick (*Ornithodorus moubata*). The tick also transmits the infection to its progeny. They hide in the cracks and in the mud floors of the old native huts and bite the sleeping inmates, or the material from the feces and the coxalglands when rubbed into wounds, cause infection. Another dreaded disease is Yellow Fever, transmitted by a mosquito *Aedes calopus.* The infective principle belongs to the group known as Filterable Viruses. Among both animals and plants there are many diseases of this nature, and if there are any living organisms they are either too small to be seen, or our methods are not capable of revealing them. The infective principle, or "contagium" as it has been also named, is able to pass through any of the fine filters that are capable of preventing the passage of the smallest known organism. These diseases of plants are commonly named Mosaics or Chloroses, and their number is continually increasing. In America, many have been definitely proved to

be transmitted by insects. One of the best known is Curly Leaf of the Sugar Beet, of which the chief insect that transmits the contagium is the Leaf Hopper—*Eutettix tenella*. California is endeavouring to control this insect by the use of parasites, and for that purpose thousands of Australian leaf hoppers of close relationship, which were found to be kept in natural control by native parasites here, were sent to California two to three years ago in order to breed out those parasites for transfer to *Eutettix tenella*.

Various species of aphids have been proved to act as disseminators of such diseases as the mosaics of tobacco, tomato, sweet pea, sugar cane, cucumber, and bean.

We have many examples of chloroses and mosaics in Australia, but to what extent any of them are infectious we do not know. They occur among such plants as the vine, apple, tomato, potato, bean, sweet pea, banana, and sugar cane. The usual practice is to treat the soil for some physical or chemical defect. Probably some of these chlorotic conditions will be found to be caused by a filterable virus, and the "Bunchy Top" disease of the banana in northern New South Wales and Queensland, as well as in Fiji and Ceylon, is one that might be investigated from this point of view.

III. Indirect Association.

Insects are often indirectly associated with certain diseases by causing wounds, which act as entrance points for the infective principle brought there by some other agency. How often do we come across the term "wound parasite" in the text-books on plant pathology? The *Melanconium* fungus, or Rind disease of sugar cane, is stated to be a wound parasite, Cobb claiming that stem-boring beetles and leaf hoppers are the cause of the wounds.

Among bacterial diseases the angular leaf spot of the cotton (*Bm. malvacearum*) in the United States of America is caused by the entrance of germs into leaf injuries by Jassids. The disease is not recorded for Australia.

It will be seen that the work of insect transmission of disease demands the co-operation of the pathologist and the entomologist. It will be necessary to work out the habits and the anatomy of the insects, and even to breed disease-free insects to act as controls in experimental work. The whole course of the organism on or through the insect, the question of the transmission of infection to the offspring, the length of time that virulence is maintained in the insect or after passing through the insect, and the number of generations that may be infected, will all require careful determination. How soon after taking up an infective principle is transmission of the disease possible, what is the exact method of transmission (by bite, feces, &c.), and from what parts of the insects (*e.g.*, salivary glands, crop, &c.) can the contagium be derived, are some of the problems that require solution, and will demand careful experimental work by well-trained investigators, working in co-operation. When will Australia profit by the lessons so plainly given by the United States?

The Leather Industry.*

For some time past the Institute of Science and Industry has been conducting investigations into tanning problems, more especially those connected with the use of mangrove and red gum. In co-operation with the West Australian Government, the services of Mr. Salt, a leather chemist, have been obtained for a definite period, and he will continue the investigations under a scheme of work already decided upon, and probably, later on, initiate further investigations. The question of the Institute co-operating with the tanning industry in a scheme of research work has also been opened up with the Federated Master Tanners Association.

By **JOHN ARTHUR WILSON.**

In the hands of men thoroughly trained in modern chemistry, capable of original research, and provided with the facilities of a tannery, chemistry will probably eventually revolutionize the industry. But in the hands of less able men it is a source of danger that many a tanner has learned to his sorrow, with the result that even to-day a number of tanners either employ no chemist at all or else limit the work of those they do employ as chemists to mere analytical routine, and this in the face of the fact that the processes used in making leather are essentially chemical. The leather chemist has made considerable progress, but it has been small compared to what might have been expected from the progress of the pure science. Yet it is not difficult to see why greater results have not been achieved in the field of leather chemistry; the great majority of men who enter the tannery as chemists have an education no greater than that ordinarily required for the degree of bachelor of science, and this alone is entirely insufficient to cope with the real problems of the industry.

Industry Developed Through Empirical Evolution.

The manufacture of leather is a most complex chemical industry and many of the processes in use to-day are the results of centuries of rule-of-thumb juggling. Along with the development of processes, accompanied as they often were by very costly failures, the practical tanner acquired an appreciation of the extreme danger of deviating very far from established practice. If he thought a process could be improved, he would first make only the slightest change and then wait weeks, perhaps months, to note any effect upon the finished leather. If no difference, or possibly a slight one for the better, could be detected, he would then institute a bigger change. Often it would be found that a small improvement in one process necessitated corresponding changes in several other processes. The young chemist usually fails to appreciate the need for this extreme caution, and he is often ignorant of his ignorance of the fundamental chemical principles involved in making leather. When such a man is given free rein in the tannery, the results are much more likely to be fatal than profitable.

* Reprinted from *Chemical and Metallurgical Engineering*, Vol. 23, No. 10.

Study of Fundamental Principles Essential.

The first applications of chemistry should be devoted to investigations of the molecular mechanism of present processes, the fundamental principles of which are not yet definitely known. Any increase in knowledge in this direction would permit the establishment of more satisfactory systems of control over the processes. In such investigations it is likely also that new principles would be discovered, and these might form the basis for new and better processes. Because much of the necessary experimental work would require very refined apparatus and great skill in accurate measurements, it would seem that the best results would come from close co-operation between the industry and the university.

With little extra work and no sacrifice of any of the objects in view, the chemist of the university could make much of his research in pure chemistry of direct value to the industry if only he were aware of the industry's needs. Often a very elaborate and painstaking research would prove of the greatest value to leather chemistry if a few additional data had been obtained, which would have been easy enough with the apparatus set up and the work in full swing, but which would present formidable difficulties to the tannery chemist without suitable equipment. It would undoubtedly prove very profitable for the industry to finance research on a large scale at the university, and all results of such work should be published freely to be of greatest good. While the work would be primarily concerned with the chemistry of leather manufacture, it will be seen from the problems now to be outlined that the field is so broad that the gain to pure science would probably be fully as great as that to the industry.

Soaking the Hides.

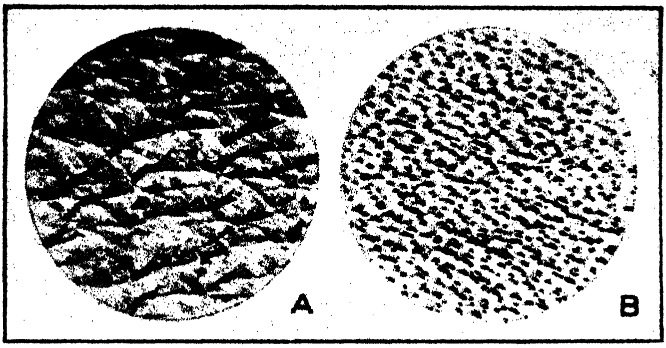
Hides are received at the tannery in any of four different conditions: fresh, salted and wet, salted and dried, and dried without salting. The first of the chief operations is "soaking," which consists in putting the hides into vats of water and changing the water frequently until the hides are clean and have reached equilibrium with the water; usually several days are required. Dried hides absorb water very slowly, but they must remain in the soak vats until they have acquired their normal amount of water or the leather later on will not have the proper suppleness. The process of imbibition is sometimes hastened by adding alkalis to the soak water.

Unhairing.

The next step is to free the hides from hair and epidermis, and this is commonly done by putting the hides into saturated lime water containing an excess of lime and some sodium sulphide. Since these liquors are used over and over again after restrengthening, they generally contain decomposition products of the protein constituents of the hide, such as polypeptides, salts of aminoacids, amines, and ammonia, and all of these seem to play a part in this process, which is known as "liming."

After the hides have been in the liquor for several days, the malpighian layer of the epidermis is destroyed and the corneous layer and

the hair may simply be rubbed off, and this is done on a suitable machine. Sometimes arsenic sulphide is used instead of sodium sulphide to "sharpen" the limes, and similar use has also been made of lye and of ammonia. In earlier times lime was used alone, but the action of pure lime liquors is extremely slow, and satisfactory results were obtained only with old liquors that had become heavily charged with decomposition products of the hides, and probably also with bacteria. Another method, once widely used, was to put the hides into a warm chamber where the epidermis was destroyed by putrefaction. Where



GRAIN SURFACES OF GOAT SKIN (A) AND CALF SKIN (B) (× 8).

the cost of labour has been large compared to the value of the hair, some tanners have employed strong solutions of sodium sulphide alone to destroy the hair, the hides being practically free from hair and epidermis when hauled from the vats. An unhairing action can also be produced by dilute solutions of ammonia and by pancreatic enzymes. All of the processes mentioned leave something to be desired, and the whole subject of unhairing is in need of a much more thorough investigation than has yet been made.

Deliming.

Two more general processes complete the preparation of the hides for tanning: the removal of lime or other alkalis from the hides and a curious process known as "bating." The bulk of the lime is removed simply by washing, and the remainder, which has either carbonated or is combined chemically with the hide protein, is removed by treatment with dilute acids or is sometimes allowed to remain in the hides until removed by the acids present in the tanning liquors.

Bating or Puering.

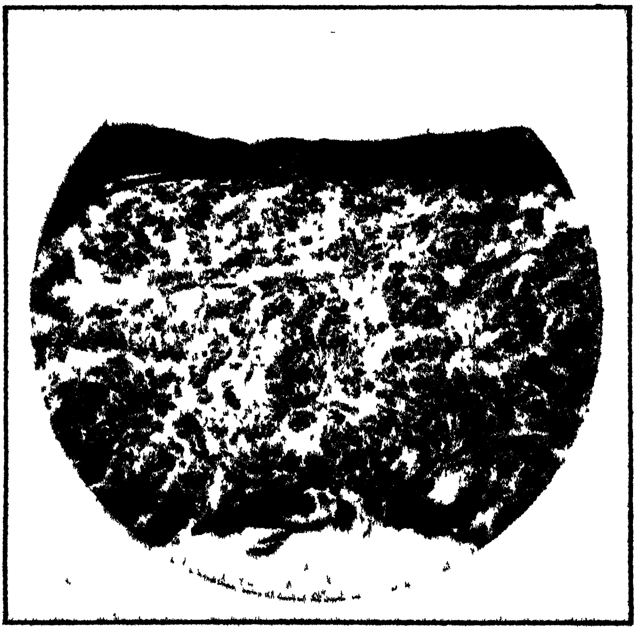
Bating, or puering, originally consisted in putting the hides into vats containing a warm infusion of the dung of birds or dogs and leaving them there until the "plumping" action of the lime liquors had been counteracted and the hides had become soft and raggy. Just how the early tanners hit upon this process is a matter for speculation, but the fact remains that the method appeared to be necessary to get certain desirable results in the leather. Investigations, notably that of J. T.

Wood, of Nottingham, seemed to indicate that pancreatin is the active constituent of the dung, and now mixtures of pancreatic enzymes and ammonium chloride largely replace the obnoxious dungs. But the question as to why we bate at all is still a moot one. Many tanners, especially those making heavy leathers, do not bate; others claim that good leather cannot be made without bating. If the object of bating were simply to counteract the alkaline swelling of the hides coming from the limes, this could easily be accomplished by reducing the hides to a nearly neutral condition, and some tanners claim that this does produce the desirable effects of bating. Recently, however, evidence has been brought forth to show that, in bating, the elastin fibres of the papillary layer are digested by the enzymes present.

The foregoing represent what are known as the "beam house" operations, and their prime object to free the hides from everything excepting the collagen fibres and hyaline layer of the true skin, which is then ready to be tanned.

Tanning.

There are numerous methods of tanning, of which only the two most important will be mentioned: these are vegetable tanning and chrome tanning. While the origin of vegetable tanning is lost in antiquity, chrome tanning is a product of the last few decades and is often referred to as the one big contribution of chemistry to the leather industry. These two processes and the materials involved in them have been the subject of the great majority of investigations made in the industry, and yet it cannot be said that we have made more than a start in the direction of solving the chemistry of tanning.



CHROME TANNED COWHIDE (× 18).

Chemistry of Vegetable Tanning Process Still Obscure.

Vegetable tanning, as its name implies, consists in the conversion of hide into leather by means of material procured from plant life. The barks of trees, such as the hemlock and oak, the wood of quebracho, chestnut, &c., and the leaves and fruits of many plants contain matter which is soluble in water and capable of tanning hides. The hides upon coming from the beam-house are first suspended in vats containing very dilute solutions of these tanning materials, each day or two they are moved into stronger liquors, and are finally hauled out when the colour of the tan liquor has completely penetrated the hides as shown by examining a cutting in the thickest part of a hide.

Simple though this process may seem, its chemistry is exceedingly complex. Many theories of the mechanism of the process have been propounded, and there is still no general agreement on any theory. The process is one in which the tanner finds he dare not deviate much from his daily practice. If the liquors become too strong or too acid, there is danger of the grain surface becoming rough or wrinkled to such an extent that it cannot later be made smooth and the value of the leather is lessened considerably. If the liquors are not sufficiently acid, the tanning action is retarded and the liquors and leather become darker in colour through oxidation.

Different kinds of tanning materials often produce very different kinds of leather, but it is still a matter of some doubt as to whether such differences are due to differences in the active tanning principles which they contain or to differences in the content of foreign matter, such as acids and sugars or other fermentable substances. Some evidence has been brought forth recently to show that astringent tanning materials differ from milder ones chiefly in possessing less of non-tanning matters of acid character. Many difficulties that sometimes confront the tanner in the later processes are traceable to slight changes in the condition of the tanyards.

Vegetable Tanning Problems Suited for University Research.

Much of the research required on the subject of vegetable tanning is especially suited for university laboratories. Among the more important problems in this connexion might be mentioned the chemistry of the tannins, the swelling of the collagen fibres by dilute acid solutions and the opposing action of the tannins, the diffusion of the constituents of a tan liquor into the substance of the hide fibres, the effect of change of acidity upon the tanning action, and the nature of the tanning action itself. It will be found convenient in university studies of these problems to use a standard hide powder which has been placed on the market by the Standard Manufacturing Co. of Ridgway, Pa., especially for use in tannin analysis. This powder is made up chiefly of purified collagen fibres containing about 12 per cent. water, 0.3 per cent. ash, and about 0.8 per cent. of fat.

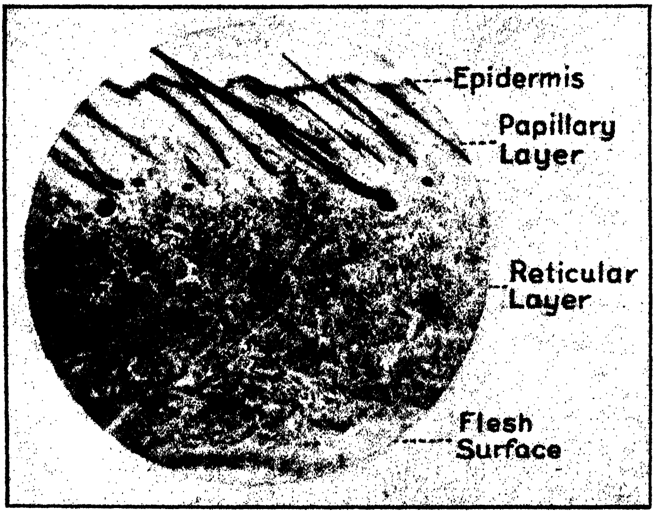
Chrome Tanning.

Chrome tanning consists in treating the hides first with a solution of sulphuric acid and common salt, a process known as pickling, and then with a solution of basic chromic sulphate corresponding roughly to

the formula Cr (OH) SO_4. Since chrome liquors are usually made by reducing sodium dichromate, they also contain a considerable amount of sodium sulphate. Sometimes the hides are taken from the pickle bath and put into a separate tanning bath and sometimes the chrome preparation is added directly to the pickle liquor containing the hides. After the hides have been drummed or churned in the chrome liquor for a day or more, the green colour of the chrome will have penetrated them completely, and they are then tested to determine whether or not the tannage is complete. This is done by keeping strips of the leather in boiling water for five minutes or longer; if they are fully tanned, the boiling water will apparently be without effect upon them, but any unchanged collagen present will be converted into glue, causing a considerable distortion of the strips. When the hides are not fully tanned at this stage, it is generally necessary to reduce the acidity by a cautious addition of alkali.

Complexity of Chrome Tanning Process.

It would seem that tanning with inorganic salts and acids should be less complex than vegetable tanning, but the process is nevertheless almost bewildering in its complexity. Work now in progress at Columbia University has already shown that chrome liquors are much more



COWHIDE FROM SOAK VATS (× 17).

complicated systems than we previously had reason to believe, although any one who has done much experimenting with chrome tanning must have experienced the annoyance of not being able to duplicate certain results because of the variation of some unknown and therefore uncontrollable factors.

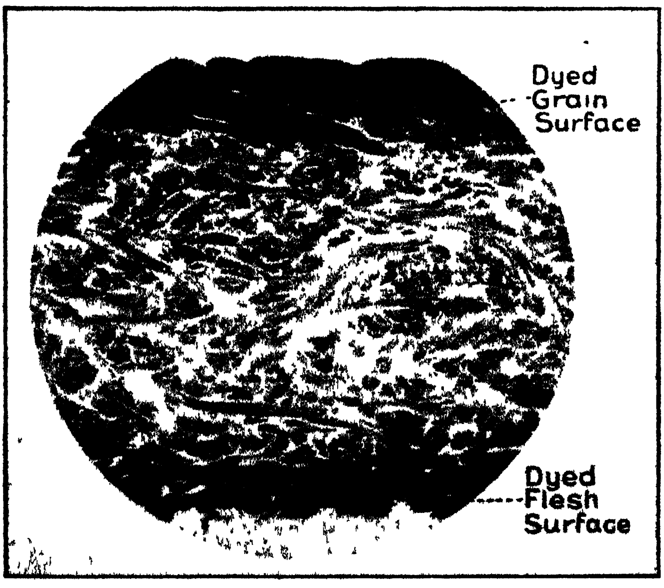
A. W. Thomas and his collaborators at Columbia have shown by hydrogen electrode measurements that the acidity of a chrome liquor changes with the time, especially just after some change has been made in the liquor, such as dilution or the addition of acids or alkalis. The

acidity is markedly increased by adding neutral chlorides, such as common salt, and is decreased by neutral sulphates. They showed also that neutral salts have a similar action upon solutions of hydrochloric acid or sulphuric acid. It is quite evident, then, that before we can hope to control every factor in chrome tanning we must learn more about pure solutions of acids and salts. It is in further studies of this kind that the pure chemist can be of very great service to the industry, and it is desired that he should appreciate the possibilities for applying his discoveries. An increase in the acidity of a chrome liquor retards the tanning. The addition of sodium chloride increases the acidity, and, as would be expected, retards the tanning On the other hand, the addition of sodium sulphate decreases the acidity, but it also retards the tanning. The explanation of these facts surely lies within the province of the pure chemist.

The writer has done much work on theories of tanning, and believes that vegetable tanning consists of the combination of collagen and tannin, yielding collagen tannate or vegetable leather, and that similarly, in chrome tanning, we have the formation of a chromium collagenate, collagen being amphoteric. On this basis the combining weight of collagen appears to be 750, or some multiple or submultiple of 750 This view has been contested, but its truth or fallacy should interest the pure chemist.

Fatliquoring and Stuffing.

After tanning, by either the chrome or vegetable process, the hides are fatliquored or stuffed. Fatliquoring which is applied to light leathers consists in drumming the leather with a hot emulsion of suitable oils. If the condition of the leather is right and the proper quantities of materials have been used, the leather will remove



VEGETABLE TANNED CALFSKIN (× 40).

practically all of the oil and leave nearly pure water behind. Stuffing consists in treating the hides with greases, such as a mixture of cod oil and tallow, which are often added hot to the dry leather. The object in applying oils to leather is to prevent brittleness, to increase strength, and to impart other properties desirable for certain types of leather, such as waterproofness, &c. There is much room for experiment in the making of suitable emulsions.

Dyeing.

Another important process is the dyeing of leather. A pack of skins which has been kept together through every process may emerge from the colour drum with some skins light in colour and others dark. Any one skin will be uniform in colour, but one skin may be much darker than another. The writer has found that slight differences in the amounts of acid carried by chrome-tanned skins cause them to take different amounts of dye from the same bath, but difference in acidity of different skins scarcely furnishes the full explanation.

University Chemists Should Develop Theories.

The research work which the industry needs is of two very distinct kinds, the one pertaining to the discovery of facts and of reasons for certain processes, and the other the correlation of those facts and application of them to actual leather manufacture. The former requires an extraordinarily broad knowledge of general chemistry and great skill in dealing with specific problems in many different fields of chemistry. For example, in studying the mechanism of bating, the investigator should have a knowledge of both bacteriological and enzyme actions; he should be familiar with the action of electrolytes upon proteins and with the work of H. R. Proctor, of Leeds, and others upon the swelling of proteins in certain solutions by absorption of water, and he should be skilled in preparing and staining cross-sections of the hide for microscopic examination.

At the end of his investigation he might be able to say with certainty that bating has two and only two important functions: the counteraction of the swelling caused by the limes, and the removal of elastin fibres from the papillary layer. Such a statement properly substantiated would do much to elevate a now uncertain process to a scientific basis. In the study of chrome tanning the investigator must have some very refined apparatus, particularly a good hydrogen electrode, and he must have a very thorough knowledge of physical chemistry. He might be able to settle definitely the molecular mechanism of tanning and show exactly what essential *rôles* are played by the salts and acids present. For the purpose of solving problems of this kind the university is vastly better prepared than the tannery.

Chemists Familiar with Tannery Practice Should Apply Theories.

But when it comes to correlating such facts as the university chemist might discover and applying them to actual leather manufacture, a tannery is necessary as well as a chemist thoroughly familiar with its practical workings, and this of course the university could scarcely be

expected to furnish. This would of necessity be the work of the tannery chemist, and such tanneries as do not employ chemists might fail to profit by the work done at the university. For example, suppose the university chemist proved the value of bating and recommended the use of a certain type of bating liquor that was slightly alkaline. A tanner who now delimes his stock with dilute acids, but does not bate, reads of the great discovery and attempts to profit by it. He follows the instructions carefully, but the resulting leather is much inferior to what he has been making. He concludes that bating is detrimental and remains satisfied with his deliming process. He has gained nothing from the research simply because he did not have in his plant a chemist with sufficient training and knowledge of the tannery to see that good results could not be expected until the vegetable tanyard was altered to conform to the changed condition of the stock coming from the beamhouse. Before instituting the bating process, the stock arrived in the yard in a slightly acid condition. After bating, the stock was slightly alkaline. To meet this changed condition, either the tan liquors should have been more strongly acid or the stock should have been put through the usual deliming process after the bating. Thus a given discovery might be hailed as a success by certain tanners whose processes chanced to be specially suited to receive it, while other tanners would consider it a failure.

The industry needs the help of the university chemists, and it also needs highly trained chemists holding positions of responsibility in its tanneries; its development will be greatest when these two groups of chemists learn to do teamwork.

The Migration and Dispersal of Weeds.

By ELLINOR ARCHER, M.Sc.

A weed may be defined as a plant which is growing where some other plant would be of greater economic importance, or where it is desired that no plants should be grown at all. It follows from this definition that a plant may be a weed in some places and not in others. To take, for example, the true Couch Grass (*Agropyrun repens*), which is a plant with a slight fodder value, and one which will grow in practically any soil. When it is in poor soil which would not support more nutritious fodder it may be considered as a useful plant, but when it is growing on soil which could support some such grass as Cocksfoot (*Dactylis glomerata*) it is a weed, and when it spreads into cultivated land or gardens it is a very troublesome weed, which is particularly difficult to eradicate owing to its hard, quick-growing, underground stems or runners, which are rather difficult to destroy. Another example is the Foxglove (*Digitalis purpurea*), usually a garden plant, but it increases rather rapidly, and sometimes spreads into neighbouring fields, where it at once becomes a noxious weed, because it contains a sufficient percentage of digitalin to be very injurious to stock. The digitalin which it contains also makes it of some value as a medicinal plant. Many plants are weeds under any circumstances, having neither fodder, ornamental, nor economic value, and it is interesting to realize how universally many of these plants are spread over the civilized world. In North America, the Indians knew the smaller Rib Grass (*Plantago lanceolata*) by the name of "White Man's Foot," because it seemed to spring up wherever the white man had passed. Since weeds follow civilization, it is obvious that the spread of weeds, or more especially the migration of weeds, from one country to another, is caused by man, sometimes consciously, but generally accidentally.

THE MIGRATION OF WEEDS.

There are a few outstanding cases in Australia in which weeds have been deliberately imported from other countries by some misguided person either for sentimental reasons or because the plant has some little value for ornamental purposes. In the old days pioneers were anxious to make their Colonial settlements as much like their original homes as possible, and it seems most likely that for some such reason the popular but troublesome Scotch thistle (*Onopordon acanthium*), with its pretty purple flowers, but useless spiky foliage, was first brought to this country.

There have been a good many cases of plants introduced for their ornamental value spreading to such an extent that they have caused a considerable loss of money. Perhaps the most notable example of this is the Water Hyacinth (*Eichornia speciosa*); this is a plant with a long racemes of pale lavender flowers, which are very attractive. The plant is a native of Guiana, South America, and has been introduced, with disastrous results, into a number of countries for the beauty of its flowers. In warm climates it is noted for the extraordinary rapidity of its growth and the quickness with which it spreads. In some of the rivers of Queensland and northern New South Wales it grows in such profusion that it blocks the whole river and interferes with traffic.

The very troublesome weed of the Bright district (Victoria), St. John's Wort (*Hypericum perforatum*), is also supposed to be a garden escape. It has a rather delicate yellow flower, the attractiveness of which caused its introduction into Victoria, where the conditions suit it so well that it grows to twice the size that it usually attains in England. It spreads with tremendous rapidity by means of long underground stems, and since it contains an oil which is slightly injurious to stock and very distasteful to them, and is very woody, it receives no check from grazing animals.

The plant known in Victoria and New South Wales as Paterson's Curse, and in South Australia as Salvation Jane, and whose botanical name is *Echium plantagineum*, is also a garden escape. It is characterized by long spikes of blue or faintly purple flowers; the flower stalks and leaves are covered with coarse hair, and are very rough, making it most unpalatable to stock. It has spread tremendously in parts of New South Wales, and causes a lot of trouble.

The majority of weeds which have reached this country have been introduced accidentally, or by carelessness.

Agricultural seed is very seldom absolutely free from impurities such as dust, small particles of seed pods, and more particularly weed seeds. It is impossible to grow most crops without a good many weeds growing at the same time, and it is equally difficult to collect the seed from the crop without collecting the weed seeds as well. Certain weeds are habitually found in certain crops, and the seeds of these weeds naturally form common impurities in the crop seed. Lucerne crops are frequently infested with dodder (*Cuscuta trifolii*) (Fig. 10), and this means that lucerne seed is frequently adulterated with dodder seed. These seeds are particularly small and dust-like, and easily mistaken for particles of earth mixed with the kidney-shaped lucerne seed, and they can only be separated from it by careful sifting. Charlock or Wild Mustard (*Brassica sinapistrum*) is a weed which very frequently appears in a cornfield, usually having been introduced with impure seed. The same may be said of a great many of the Cruciferæ, which are troublesome weeds in cultivated ground. The Wild Radish or Jointed Charlock (*Raphanus raphanistrum*) has a fruit which breaks into segments, each segment containing seed, and looking very much like a grain of oats, which makes it particularly difficult to separate from that crop. Grass seeds for planting in pasture land are a particularly fertile source for the introduction of weeds. The seeds of all grasses are so small, and so much alike, that it is particularly difficult to separate them, and all sorts of impurities in the way of Ragwort, Stinkwort, thistle seeds, &c., can be mixed with them, and require careful investigation before they can be detected. It is probable that the weeds introduced into agricultural seeds are the main channel by which aliens are introduced into any district.

The practice of packing fragile goods in cheap straw or hay is one fraught with great danger to the farmer. The straw used is naturally some of the cheapest, and is mixed with numerous weeds. As a general rule, after it has been used for packing, it is thrown on to the rubbish heap, or used as bedding in the stable, and thrown on to the manure heap later. This provides the weed seeds with an excellent opportunity for germination, and some new weeds are soon spread throughout the farm.

Sand and earth used as ballast in an empty ship, and dumped in a convenient spot at the ship's destination, carries with it its original flora. As it has usually been taken from some waste spot, this flora will be a fine crop of useless and noxious weeds. Any of these that have survived the voyage are being given an excellent opportunity to make a way for themselves in a new country.

The migration from farm to farm and from district to district is frequently affected by unclean agricultural instruments. The plough or harvester will pick up bulbs, stems, and seeds in an infected district and carry them to clean parts.

The migration of weeds may be carried on to a certain extent by causes which, as a general rule, lead to their dispersal over a more limited area. Birds exert a great influence on dispersal, many seeds having developed special devices enabling them to cling to feathers, beaks, and claws. Migratory birds may carry a few isolated seeds over considerable distances, but the amount of harm done by the carrying of weed seeds in this manner is very slight. Many seeds cling to the wool and fur of animals, and this has led to the establishment of a small colony of 46 typically Australian plants on the banks of the River Tweed, in Scotland, the seeds of which have been deposited there by the scouring of Australian wool in the river. It is a popular fallacy that the seeds of thistles, and other plants with special adaptations for catching in the wind, can be blown immense distances. As a matter of fact, the seed itself is seldom carried very far, it is only the disarticulated pappus which will be found floating in the air some miles from any plant of the same species. As a general rule, seeds are only carried across oceans, and from country to country, by man himself.

It often happens that noxious weeds are not introduced directly from the country to which they are native, but come in a roundabout way from other countries in which they have previously been established. The Cape Weed (*Cryptostemma calendulacea*), a weed which is widely spread through our meadows and pastures, is a native of Africa, but reached Victoria from Western Australia; whereas dodder, a native of Europe, was introduced into Australia by impure seed from New Zealand.

The Dispersal of Weeds.

The dispersal of a weed in a district into which it has once been introduced is a matter practically dependent upon the plant itself and upon the adaptations it has developed to insure dispersal. In order to become a troublesome weed, a plant will have developed along a line which in some way enables it to spread more rapidly than the surrounding plants, to withstand unfavorable circumstances, to be unpalatable to browsing stock, or in some way have an advantage over its neighbours. To take, for example, the common little Chickweed (*Stellaria media*), this tiny, insignificant plant grows and ripens its seeds in six weeks. Each plant bears a good many flowers, and every flower produces numerous seeds. This, together with the fact that the seeds can retain their vitality for several years, gives the plant every opportunity to spread rapidly and to keep its place in any district where it has once appeared. Many plants, such as the Cow Thistle (*Carduus arvensis*), St. John's Wort (*Hypericum perforatum*), Bracken Fern (*Pteris aquilina*), and the Nettles (*Urtica*), have a strong development of underground horizontal stems. These spread

in every direction and enable the plant to increase rapidly, and at the same time make it much more difficult to exterminate. Merely cutting the part above ground will not have any permanent effect on the weed, as it sprouts again from the horizontal stem, and this stem has to be ploughed up and destroyed before the plant will disappear.

Weeds first appear along the sides of some main thoroughfare, along a railway line, or a main stock route. They very often become established on the waste ground in or around a town, and from there are liable to be dispersed by various means throughout the whole district.

Wind.

The seeds of many plants are especially adapted for transport by wind. Many members of the *Compositæ* (thistles, dandelions, prickly lettuce, groundsel, &c.) are fitted with an apparatus resembling a tiny parachute, and known as a pappus (Figs. 1, 2, and 3). This is caught up by the wind and lifts the seed with it, carrying it a little way before the heavy seed drops off. In this way, a windy day could pretty well infect a wide area with the seeds of a plant such as Prickly Lettuce (*Lactuca scariola*). Other seeds are fitted with wing-like outgrowths to the seed coat; the seed itself is very light, and the wings expose a comparatively large surface to the force of the wind, which picks the whole thing up and carries it for some distance. The best example of this, although it can hardly be classed as a weed, is the seed of the common Elm Tree (*Ulmus campestris*). Many seeds are covered with thick woolly or hairy coverings, which serve to assist in their dispersal by wind, *e.g.*, the seeds of Cape Weed (*Cryptostemma calendulaceæ*) are buried in a mass resembling cotton wool.

In some cases, the seeds have no special adaptation for wind dispersal beyond their size. They are so tiny that they are blown about like dust, in fact, dust is usually composed, to a certain extent, of tiny seeds. The obnoxious Bracken Fern (*Pteris aquilina*) has such small seeds or spores that they are hardly visible to the naked eye, but they are practically always present in the air, and this enables bracken to get a hold in land in which the former vegetation has been destroyed before any other plant.

It is not always the seed only which is carried along by the wind, but the plant itself, or a large part of the plant, can be rolled along the ground for considerable distances. In Windmill Grass (*Chloris virgata*), the whole flowering head, which consists of a number of spikes radiating from one point like a windmill, breaks off and rolls along the ground, dropping the seeds as it goes. In some of the Medics, Lucerne (*Medicago sativa*), Snail Medic (*Medicago scutellata*), and Burr Medic (*Medicago denticulata*), the seed pod is rolled into a tight ball, which can be blown along the ground.

Water.

Many seeds are carried for long distances down streams and water-courses, and become established at points along the banks far from their original home. These will chiefly be wind-blown seeds which have reached the river from neighbouring fields with the help of the wind. As a general rule, new weeds do not have a very good chance of getting a hold along the banks of a normal water-course—the vegetation is usually too thick along the banks to allow much room for strangers.

Floods are, perhaps, responsible for the spread of weeds a great deal more than the normal water-ways. Flood waters cover ground which is hard and baked at the end of a long summer, and on which dried plants with their ripe seeds are lying about in hundreds. These are picked up and rushed along by the force of the water, which, when it recedes, drops the seeds and leaves the ground in an ideal condition for their germination. The flooding of the Murray has been responsible for the crossing of numerous weeds from one State to the other—the seeds could never have blown right across the river, and could not have been carried over in any quantity in any other manner. St. John's Wort (*Hypericum perforatum*) has been spread down the Ovens River in the silt from the dredging which is carried on to such an extent there. Whole plants are embedded in the mud and carried down stream. Heavy rain will also assist in scattering seeds for short distances, more particularly on sloping ground.

Animals and Birds.

Animals and birds effect the dispersal of weed seeds over rather wider areas than either wind or water. Their action may be either active or passive according to the nature of the seed. Many fruits and seeds develop special devices to enable them to cling to the hair, fur, or feathers of any passing animal or bird, which may carry them for quite long distances. The devices which enable the seeds to cling are usually in the nature of hooks or spines which cover the fruit, the seed, or sometimes the whole plant. Sheep's Burnet (*Acæna sanguisorba*) is a small plant with its fruit in a cluster forming a head. Each fruit contains only one seed, and is provided with four arrow-headed barbs, which catch on to everything (Fig. 4). When the seeds are ripe, the whole head is easily detached from the plant, and when the barbs catch onto a passing animal, the head breaks off, and is carried away to be dropped later when the animal sets to work to rid itself of its unwelcome visitor.

The wool of sheep that have been feeding in pastures infected with this or other weeds with spiny fruit, becomes seriously deteriorated in value by the number of seeds clinging to it. Some of the worst offenders in this way are the Bathurst Burr (*Xanthium spinosum*), the fruit of which is covered with strong hooks (Fig. 6); Burr Clover (*Medicago denticulata*), with teeth-like attachments to the coiled seed pod; and Burr Grass (*Cenchrus Australis*), with a spiny seed. The awns of grasses also catch in the wool of sheep and do a good deal of damage (Fig. 5). In some cases, the spines and awns are so sharp as to do bodily harm to the animal to which they become attached. Sheep and horses are lamed by treading on the spiny seeds of Caltrop (*Tribulus terrestris*). These are particularly sharp and strong, and they penetrate some way into the flesh, the seed breaks off, but the spine remains, and causes a festering sore.

It may be the whole plant which bears the spines or prickles, and when these catch in anything, a part of the plant itself is broken off and carried to a new spot, where it takes root. This is one of the methods by which the great pest of Queensland, the Prickly Pear (*Opuntia monacantha*), is spread, as practically every portion of this plant can strike root for itself.

Some seeds are surrounded by a gummy, gelatinous mass, which enables them to cling to each other and to the beaks and claws of birds. The small seeds of Hoary Cress (*Lepidium draba*) and Narrow Leaved Cress (*Lepidium ruderale*) as long as they are wet are enclosed in a sticky, mucilaginous mass which will cling to anything.

The active part played by some animals, but more especially by birds, is due to the development of edible fruits. These, when they are ripe, assume a conspicuous colour, and the fruit stalk twists or elongates, so that they will be in a more prominent position and be more noticeable. Although the fruit itself is edible, the seeds enclosed are indigestible, and pass through the alimentary canal unharmed, to be deposited at some distant spot. Attractive edible fruit are seen in the Blackberry (*Rubus fruticosus*) (Fig. 9), African Box Thorn (*Lycium horridum*) (Fig. 8), Sweet Briar (*Rosa rubiginosa*), and Prickly Pear (*Opuntia monacantha*). The edible fruit may not always be conspicuous; if it is small and green it will probably be devoured by stock with the rest of the plant, the seeds as before passing through unharmed. In some cases, especially with grasses, the seed is not only edible, but particularly palatable, with the consequence that the greedy bird swallows more than it can digest, flies a little distance, and then disgorges the excess.

It will be seen from the above that roads along which stock habitually travel will be especially liable to receive the seeds of numerous aliens, and if these are allowed to germinate and the plants to flourish, the roads will form the starting point for all sorts of troublesome weeds.

Sling Fruits.

The spread of some weeds over short distances may be accomplished by the plant itself without outside aid. The pods of many plants of the pea family, *e.g.*, the Common Gorze (*Ulex europæus*), as they ripen are burst open along one edge. The two valves undergo a spiral torsion and the seeds are flung to a little distance by the violence of the action (Fig. 7). The whole movement is due to the drying and shrinking of a particular layer of cells when exposed to a hot sun. The action is accompanied by quite a loud report, and the popping of these seed pods can be heard on a sunny day all along a gorze hedge. The little Wood Sorrel (*Oxalis acetosella*) has its seeds enclosed in a four-valved capsule. When the fruit is ripe these valves split apart, and curl outwards with rather a violent motion, which jerks the seeds away. Any of these actions are sufficient to carry the seed well clear of the parent plant, and gives the weed an opportunity to spread.

Creeping Fruits.

The stiff bristles and awns of many grasses may function in two ways. They may become attached to some animal as described above, or they may alter the position of the seed by a movement of their own. They are hygroscopic, and change their position according to the percentage of moisture in the atmosphere. When once the seeds have fallen to the ground, these movements propel them in a definite direction. The distance covered would never be very great, but it would be quite sufficient to remove the seed from the direct vicinity of the parent plant.

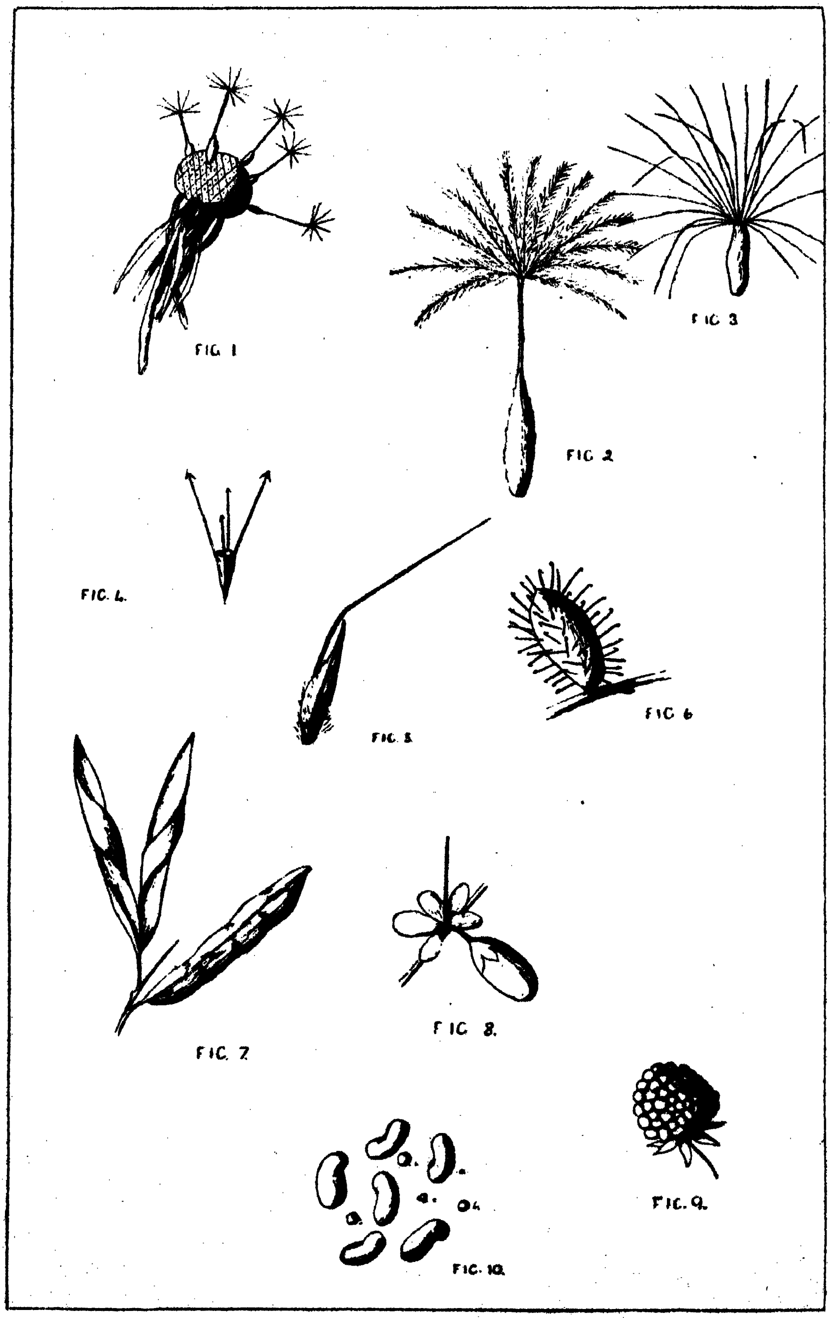


FIG. 1
FIG. 2
FIG. 3
FIG. 4.
FIG. 5
FIG. 6
FIG. 7
FIG. 8.
FIG. 9.
FIG. 10.

Offshoots.

Underground stems, creeping stems, or offshoots are the means by which a troublesome weed may considerably increase the area of ground that it covers. A plant such as St. John's Wort (*Hypericum perforatum*), which is a perennial with short runners, capable of spreading in any direction and sending up new shoots all round the original plant, can spread over a large area in a short time. In many plants, as the underground stem grows and branches, the original stem dies away behind, so that two plants are formed in the place of one. Underground stems are seen in Couch Grass (*Agropyrum repens*), Bindweed (*Convolvulus arvensis*), Stinging Weed or Nettle (*Urtica dioica*), Bracken Fern (*Pteris aquilina*), and others.

Protection from Extinction during Unfavorable Seasons.

Many weeds are noted for the persistence with which they reappear in a field after they have been eradicated by all of the more simple means. This persistence may be due to the possession of underground stems or bulbs which will sprout again every time the shoots are cut off. They have to be cut a good many times before the vitality of the stem is exhausted. The persistence may be due to the longevity of the seeds, as many weed seeds can remain dormant during four or five years and still be able to germinate. This means that, if the seeds are ploughed into the ground to a depth which is unfavorable for germination, instead of decaying, they will remain there in a dormant condition, and at the next ploughing will stand a good chance of being brought nearer to the surface and of being able to germinate.

The Bathurst Burr (*Xanthium spinosum*) produces two seeds to a fruit, but these seeds allow for propagation over two seasons, as one ripens one year and one the next, so that it takes over two years to eradicate this pest when once it has been allowed to seed.

Some weeds are able to grow in land in which any other vegetation is quickly destroyed. The Onion Grass (*Romulea cruciata*) seems to particularly favour land which is continually being trampled on. This accounts for the way in which, when it becomes established along the sides of a road, it appears to enter the fields only through the gates. The ground just at the gate is usually hardened and bare of vegetation because it is continually being trampled on, which makes ideal conditions for the growth of the onion weed.

It will be seen from the above that when once a weed has been allowed to grow and ripen its seed, it will take time and money to get rid of it. It is, therefore, necessary to take all the precautions possible to prevent the entry of any new weeds, or when they have entered to prevent them seeding.

INDEX TO ILLUSTRATIONS.

Helium.*

No element has had a more romantic history than helium, and few are of greater interest to men of science at the present time. Its extreme lightness, its absolute inertness, its close approximation to an ideal or perfect gas, and its intimate connexion with the phenomena of radio-activity are among its most interesting properties, whilst its use for inflating airships and its possible application to a variety of other utilitarian purposes appeal especially to the student of chemical technology.

The gases from some springs in France have been shown to contain as much as 5 per cent. of helium; natural gases in the Western States of America contain from 1 to 2 per cent., but within the British Empire no natural gases have been found to contain as much as 0.5 per cent. When, during the late war, it became apparent that the use of helium would have important advantages over that of hydrogen for filling airships, the Board of Invention and Research of the British Admiralty, acting on proposals advanced by Sir R. Threlfall, asked Professor McLennan to undertake a survey of the sources of helium within the Empire, and to devise ways and means of isolating it in quantity and in a relatively pure state. Natural gases from Ontario and Alberta, Canada, were found to be richest in helium (0.34 per cent. and 0.33 per cent. respectively), and it was estimated that these sources could supply from 10,000,000 to 12,000,000 cubic feet of helium per annum. Gases from New Brunswick were found to contain 0.064 per cent., and the richest natural gases in New Zealand not more than 0.077 per cent. A natural gas from Pisa, Italy, contained no helium; the gas at Heathfield, Sussex, 0.21 per cent.; that from the King's Spring, Bath, 0.16 per cent.; and the natural gases at Pitt Meadows, Fraser River Valley, and Pender Island, on the Gulf of Georgia, British Columbia, were ascertained to possess a nitrogen content of over 99 per cent.

In 1917, a small experimental station was set up at Hamilton, Ontario, where it was found that the helium present in the crude natural gas, to the extent of 0.33 per cent., could be satisfactorily isolated on a commercial scale; and the second station was established to operate on the natural gas at Calgary, Alberta. Three methods of isolating the helium content were investigated, viz., (*a*) by utilizing the cold obtainable from the natural gas itself for liquefying all the contained gases except the helium; (*b*) by using external refrigeration only, by means of ammonia, liquid air, &c.; and (*c*) by combining methods (*a*) and (*b*). Although method (*c*) had been successfully used in the Texas field by the United States authorities, it was not adopted, as it did not appear to be economical. Method (*a*) was selected, and by suitably modifying the Claude oxygen-producing column it was found that helium of 87-90 per cent. purity could be regularly and continuously produced. Ultimately, an auxiliary apparatus was added, whereby the purity of the gas was raised to 99 per cent. or higher.

* Abstracted from a lecture delivered before the Chemical Society, by Prof. J. C. McLennan, on 17th June, 1920, and published in the *Journal of the Society of Chemical Industry*.

From the experience thus obtained it was possible to draw up specifications for a commercial plant to deal with about 56,500 cubic feet of gas per hour at normal temperature and pressure.† Six of these machines would deal with 9,500,000 cubic feet of gas daily—the average supply of natural gas at Calgary. The cost of a commercial plant for treating the whole supply from the Alberta field would probably be less than £150,000, assuming an efficiency of 80 per cent. (*i.e.*, a recovery of 80 per cent. of the helium content of the natural gas), and allowing for salaries, running costs, amortization, &c., helium could be produced in Alberta at less than £10 per 1,000 cubic feet, excluding the cost of cylinders and transport. From data so far ascertained, it is probable that the potential yearly supply of helium from all sources within the Empire would not suffice to keep more than a very few of the larger airships in commission, even if diluted with 15 per cent. of hydrogen; it might be used to fill fireproof compartments adjacent to the engines if it were decided to install these within the envelopes of larger airships.

In the course of this work, a number of collateral problems were investigated. It was found, *e.g.*, that for aeronautical purposes hydrogen could be mixed with 15-20 per cent. of helium without the mixture becoming inflammable or explosive in air. The permeability of rubbered balloon fabrics for helium was shown to be about 0.71 of its value for hydrogen. For skin-lined fabrics, the permeability to hydrogen and helium was about the same. Thin soap films were found to be about one hundred times more permeable to hydrogen and helium than rubbered balloon fabrics, but untreated cotton fabrics, when wetted with distilled water, were but feebly permeable to these gases. It was found that rapid estimations of the amount of helium in a gas mixture could be made with a pivoted silica balance, a Shakspear katharometer, or a Jamin interferometer. The latent heats of methane and ethane were determined, and also the composition of the vapour and liquid phases of the system methane-nitrogen. It was ascertained that helium containing as much as 20 per cent. of air, oxygen, or nitrogen can be highly purified in large quantities by simply passing it at slightly above atmospheric pressure through a few tubes of coconut charcoal kept at the temperature of liquid air. In the spectroscopy of the ultraviolet, helium was found to be exceptionally useful.

Among the suggested possible applications of helium are its use in industry as a filling for thermionic amplifying valves of the ionization type; for filling tungsten incandescent filament lamps, especially for signalling purposes where rapid dimming is essential; and for producing gas arc lamps in which tungsten terminals are used, as in the "Pointolite" type. However, both of these varieties of lamps possess the defect of soon becoming dull owing to the ease with which incandescent tungsten volatilizes in helium and deposits on the surface of the enclosing glass bulbs. As regards illumination, helium arc lamps possess an advantage over mercury arc lamps in that the radiation emitted has strong intensities in the red and yellow portion of the spectrum. Nutting has shown that Geissler tubes filled with helium are eminently suitable, under certain conditions, for light standards in spectrophotometry, but the amount of the gas which could be used in this way is

† A full account of the apparatus employed, with diagrams, is given in the *Journal of the Society of Chemical Industry*, July, 1920.

very small. It has recently been proposed to use helium in place of oil for surrounding the switches and circuit-breakers of high-tension electric transmission lines. If the gas should prove suitable for this purpose, large quantities could be utilized, and it has yet to be demonstrated that in this field helium possesses any advantage over the oils now used. It has been suggested by Eilhu Thomson and others that, if divers were supplied with a mixture of oxygen and helium, the rate of expulsion of carbon dioxide from the lungs might be increased, and the period of submergence, as a consequence, be considerably lengthened.

To chemists and physicists, the discovery that helium can be produced in quantity at a moderate cost opens up a vista of surpassing interest in the realm of low temperature research. It is but a few years (1908) since Onnes, after prolonged effort, succeeded in liquefying helium, and in so doing reached a temperature within approximately 1 degree or 2 degrees of absolute zero. The results obtained by him, although limited in number, are of great importance, for they show that, if liquid helium were rendered available in quantity, fundamental in formation of the greatest value on such problems as those connected with electrical and thermal conduction, with specific and atomic heats, with magnetism and the magnetic properties of substances, with phosphorescence, with the origin of radiation, and with atomic structure could be obtained. In spectroscopy, supplies of liquid helium would enable us to extend our knowledge of the fine structure of spectral lines, and thereby enable us to obtain clearer ideas regarding the electronic orbits existing in the atoms of the simpler elements. In the field of radio-activity important information could be obtained by the use of temperatures between that of liquid hydrogen and that of liquid helium; and such problems as the viability of spores and bacteria at such low temperatures could be attacked with fair prospect of success. A point to be remembered is that the supplies of natural gas from which helium can be extracted are being rapidly used up, and hence careful consideration should be given to the problem of producing helium in large quantities while it is still available, and of storing it up for future use.

The number of problems which could be attacked by the use of liquid helium is so great that it appears well worth while to press for the establishment of a cryogenic laboratory within the Empire. Such a project merits national and, perhaps, Imperial support. A well-equipped cryogenic laboratory should include—(1) A large liquid-air plant; (2) a liquid-hydrogen plant of moderate capacity; (3) a small liquid-helium plant; and (4) machine tools, measuring instruments, and other apparatus. The capital cost of such a laboratory would be £30,000, and the running costs would be covered by the interest on an endowment fund of £125,000. No better method could be imagined of perpetuating the work of the great pioneers of low-temperature research —Andrews, Davy, Faraday, and Dewar.

Prickly Pear in U.S.A.

Report by Professor R. D. WATT.

[The following report, presented to the Institute of Science and Industry by Professor R. D. Watt on the subject of Prickly Pear Investigations in the United States, will be read with interest. It will be seen that in the United States there is a difference of opinion as to the economic value of the cactus. In Australia, however, the plant has become such a pest, and has established itself over such an enormous area, that its progress has got to be checked, and the plant, if possible, eradicated, regardless of any slight economic value it may possess. In a bulletin on the subject issued by the Institute last year, it was pointed out that the Pest pear had a value as a fodder reserve in case of drought, but that experience had shown that Prickly Pear by itself did not contain sufficient nutriment to keep up the condition of animals fed upon it. The fruits are much more nutritious than the joints.]

Before leaving for my recent trip to America and Europe, I promised to make some inquiries in the United States with regard to the utilization of the Prickly Pear, especially in a desiccated form, for the feeding of live-stock. Owing to the delay in my departure caused by the strike of marine engineers, the American part of my trip was considerably curtailed, so that I was not able to make such exhaustive inquiries as I should have liked into this matter, but whenever I had the opportunity I gleaned all the information I could.

The first man interviewed was Mr. M. E. Jaffa, Professor of Nutrition in the University of California. He was of the opinion that none of the dried cactus products, except those derived from the fruits of some species, were of any value for human food, nor did he think that they were of much value for feeding cattle or other domesticated animals because of the low protein and fat content, the high fibre content, and the uncertainty as to the nutritive value of the nitrogen-free extract which constitutes from 70 to 75 per cent. of the material. No actual feeding tests had been carried out to ascertain the latter point. He was further of the opinion that the correct place for the various species of Opuntia for cattle food was a reserve for dry seasons, the cattle cacti to be consumed by cattle in their natural succulent state after the destruction of the spines and spicules, if necessary; that their main value as feeding stuffs depended on their succulence; and that to manufacture concentrated products from them by desiccation was a mistake. He was under the impression that nearly all the cactus food products companies had gone out of business, although he supplied me with a report he had sent to one company on the value of their products for human consumption, a copy of which is enclosed.

Before interviewing Professor Jaffa, I had already written to the manager of this particular company, the Cactus Food Products Company of Los Angeles, asking certain questions regarding species, processes of manufacture, analyses, and prices. A reply was not, however,

received until I reached Washington. A copy is forwarded herewith, together with a folder entitled, "Food from Cactus." It will be noted that they now make no claim to produce a food from the vegetation parts of the plants suitable for human consumption, that they are very vague and indefinite about the particular species used, and that the process of manufacture is covered by letters patent.

The price quoted is 30 dollars per ton, which would be equivalent to £6 5s. in normal times, and something like £9 at the current rate of exchange. This seems much too dear for a material which has a greater resemblance to wheat or oat straw than to any other well-known foodstuff, and about whose palatability and digestibility so little is known. They do not at present separate the fibre, but recover a trifling amount of potash from the ash of the spines and a small quantity of various "juices" whose commercial value is not stated.

While in Washington I had an interesting interview with Mr. David Griffiths, of the Federal Department of Agriculture, with reference to various aspects of the Prickly Pear problem. He has, perhaps, had a wider experience of the Prickly Pear in the United States than any other man.

Mr. Griffiths considers the Prickly Pear a great national asset, especially in the drier south-western States, and all his efforts have been in the direction of preserving the pear and encouraging its spread and growth rather than its destruction. On being asked why *Opuntia inermis* and other species had become such pests with us, he expressed the opinion that it was mainly because in Australia the various pears seed so freely and the seed germinated so readily owing to the abundant summer and autumn rainfall and the absence of severe winters. Even in Southern Texas, which may be regarded as the natural home of the pear, the seed rarely germinates owing to the erratic rainfall, and consequently the various species spread only vegetatively. In his long experience, only twice in Southern Texas and once in California, has the Prickly Pear seeded freely and germinated readily, and that with a rainfall of 5 inches in September (equivalent to March in Australia). Even then the plants did not grow to any size. He estimates that Southern Texas carries twice as many cattle as if the pear were not there. Cattle eat most of the species without treatment of the prickles, although they attack them more eagerly when the spines are singed off. He quoted the case of a herd of dairy cows from Texas which got nothing but prickly pear as "roughage," together with a certain amount of "concentrates" for over two years, and did remarkably well. There are no fewer than 200 species in Mexico and Southern United States of America of economic importance for feeding, although the most useful sorts are about a dozen closely-related species—*O. cyanella, O. alto, O. gomme,* &c. *O. ellisiana* is the hardiest spineless form, but the spineless varieties are not nearly so hardy or prolific as the spiny forms.

Mr. Griffiths was not in favour of concentration of Prickly Pear, as it is difficult and expensive to get rid of the water, and the product does not seem palatable to stock after desiccation. He, too, had the impression that all the cactus products companies had gone out of business. He drew my attention to the work of a Japanese investigator

who had found an additional difficulty in using Prickly Pear as a source of alcohol, viz., the existence of an organism or something in the pear which inhibits the growth of yeast.

With regard to the possibility of getting the upper hand of the pest pear in Australia, he offered considerable hope that the wild cochineal insect might be of use. When I told him that it attacked *O. monocantha* in Queensland, but not *O. inermis,* he seemed surprised. He stated that this insect existed all over the United States where Prickly Pears grow, and does very considerable damage, although it never completely destroys the pear.

At Chico, in California, they have a wonderful collection of Cacti growing on about 3 acres of land. Very few of the varieties are not attacked by the wild cochineal insects which threaten to destroy the plantation. Indeed, regular spraying has to be adopted to preserve them. More than 100 species are attacked, including Opuntia inermis —our common pest pear.

The reason doubtless is that the usual American species is *Coccus confusus,* not *C. indicus.*

The probable reason why the wild cochineal insect does not exterminate the pear in its natural habitat is that in places like Southern Texas when rain does come it falls in torrents, thus checking the insect, which likes dry weather.

Asked whether he had any experience of crossing different varieties of Prickly Pear (a matter of great importance in connexion with one possible line of attack on our pest pear), Mr. Griffiths said that he had not, but that, although natural cross fertilization is very rare, undoubted hybrids had been produced.

Some fuller information is contained in the latest publication of the United States Department of Agriculture on the subject, *Prickly Pear as Stock Feed,* by David Griffiths, enclosed.

The net result of my somewhat limited inquiries seems to be that there is no great hope from the utilization of the Prickly Pear as stock food by concentration or desiccation, but that more attention should be given to the plant in its natural state as a reserve for drought periods in the districts where it already exists, and that, where necessary, methods (such as singeing of the prickles) should be adopted to make it more attractive and less harmless to stock.

Incidentally two very interesting points in connexion with its possible extermination in Australia have been pointed out, viz.:—

1. That there already exists at Chico, California, a race of the wild cochineal insect which is capable of doing serious damage to our common pest pear (*Opuntia inermis*), and other species, and
2. That undoubted hybrids of the genus *Opuntia* have been obtained.

The Roma Bore: Notes on the Recent Flow of Gas.

By W. E. CAMERON, B.A., Deputy Chief Geologist, Queensland.

During the drilling of the present (No. 4) bore in April of last year, gas was first noticed by the driller in the bailings from a sandy shale from 3,602 to 3,610 feet, and again in sandstones from 3,665 to 3,677 feet, and from 3,680 to 3,690 feet. As the drilling, following the usual Californian practice, was being done with a full column of water, exercising a pressure of nearly 1,500 lbs. per square inch on the gas in the top gas stratum, and correspondingly greater pressure on the lower strata, the gas could not flow into the bore unless it had a pressure exceeding that of this column of water. Not having that pressure, no flow of gas was obtained while the column of water remained above it.

It was not judged advisable at the time to test these strata for gas, as it was not considered that the main gas stratum met with in the previous bores had been reached, and no very great flow of gas was expected from them, as no gas had been reported at these depths from the previous bores. There was also the risk involved in bailing the 10-in. casing with a column of water of about 3,500 feet standing behind it. However, in the recent repairs to the 8-in. casing, which has become fast at the bottom of the bore, the column of water in the bore was lowered some 520 feet, with a consequent lowering of the pressure of the water column on the gas stratum. This allowed gas to flow into the bore for about half-an-hour, the subsequent filling of the casing with water shutting off the flow. Subsequently in cutting the casing at 3,624 feet, the column of water in the bore was lowered some 880 feet, with a consequent still further lowering of the pressure of the water column on the gas stratum, which was thus enabled to discharge all the water from the bore and flow unchecked, with the consequent revelation that these strata contain very much greater quantities of gas than was judged possible from the records of the previous bores put down to them.

Pressure of the Gas.

There has been considerable controversy as to the pressure under which the gas at Roma exists in the strata. By some the pressure has been regarded as insignificant on account of the small flows met with in the two previous bores when compared with the enormous volumes of gas met with in oil-bearing strata in other parts of the world. The volume of flow, however, is in direct proportion to the size of aperture through which the flow takes place. In the two previous bores, the flow was seriously obstructed—in the one case by having to pass through a column of water of nearly 3,700 feet in depth, and in the other case by having to pass a set of drilling tools which were fast in the bottom of the bore, and which nearly blocked its total diameter. The small volume of gas, therefore, in these flows formed no criterion of the content of the strata, and could not be correctly taken as indicating an insignificant pressure.

Generally speaking, the pressure of gas in an oil-field or gas-field varies roughly with the depth of the stratum below the surface, increasing by from 20 lbs. to 50 lbs. per square inch for every 100 feet of depth. Although the pressure of the gas at Roma has never been measured, deduction from observed facts indicates that it is no exception to this rule.

The No. 1 bore flowed 44,625 cubic feet of gas, accompanied by 39,411 gallons of water, per 24 hours for some years, and consequently the pressure of gas where it entered the bore at 3,670 feet must at least have been equal to the weight of water in the bore at any one moment above that depth divided by the area of the cross section of the bore in square inches, otherwise the gas would not have been able to enter the bore. From these facts, the pressure can be calculated at about 1,420 lbs. per square inch. In the present (No. 4) bore, no gas flowed while the pressure of the column of water above it equalled about 1,500 lbs. per square inch; but as soon as the column was lowered to a pressure equal to 1,340 lbs. per square inch, a flow of gas was obtained. The pressure of the gas may, therefore, be almost certainly judged as being greater than 1,340 lbs. per square inch, and as less than 1,500 lbs. per square inch; also as probably a little more than 1,420 lbs. per square inch. This is at the rate of over 39 lbs. per square inch for each 100 feet of depth to 3,602, and is comparable with the pressures observed in oil-fields abroad. The insignificant pressure of the gas was used as an argument against it being a gas associated with oil, but in view of these facts this argument appears to fall to the ground.

Capacity of the Strata for Gas.

In the present bore (No. 4) gas was first met at 3,602 feet, and occurs in lower strata, in all probability, down to 3,690 feet; while in the No. 3 bore it was almost certainly met with down to 3,702 feet, which would correspond to 3,712 feet in the present bore, owing to the differences in surface levels of the two. There is, therefore, probably a thickness of at least 100 feet of strata in this area, carrying several bands of sandstone from 10 to 20 feet in thickness, charged with gas at a pressure of at least 1,400 lbs. to the square inch. Under this pressure, each cubic foot of gas at the surface will occupy only one-ninetieth of a cubic foot in the strata, or not much more than a cube with 2½-in sides.

If, therefore, the sandstones contain 1 per cent. of gas-filled spaces, each cubic foot of the rock would contain nearly its own volume of gas; and if 5 per cent. of spaces, five times its own volume. As these sandstones probably extend with undiminished thickness over acres of ground, it will be seen that even 10 feet of sandstone carrying gas is likely to be capable of supplying a very large volume of gas.

Causes of Stoppage of Flow in Previous Bores.

This question is somewhat obscure, because we have not got all the details of what occurred at the time. It may have been due to sanding up of the bottom of the bores, or to local decrease of pressure by escape of gas, and flooding by "bottom" water under greater pressure. Mr. J. B. Henderson, Government Analyst, has pointed out that, in the

No. 2 bore, which flowed gas and water for some time, the action was equivalent to an air lift, and that any interference with this action would mean the filling of the bore with water and the exercising of a pressure on the gas of a column of water 3,670 feet in depth, or over 1,500 lbs. per square inch, which was probably greater than the pressure of the gas met at 3,670 feet.

In the No. 3 bore the gas blew the column of water out of the hole at 3,702 feet; but we do not know the depth of water column that was being used. When the fire was put out and repairs to the casing were started, some water was issuing with the gas, and it seems quite probable that, in repairing the casing, the flow of this water was so checked that it filled the bore and again shut off the gas by its excess of pressure. At any rate, we now have good evidence that the bore was flowing water when the gas suddenly shut off, and it is probable, from what we now know of the gas pressure, that the pressure of the column of water would exceed that of the gas.

The Lesson of the Roma Bore Gas Flow.

The recent very great flow of gas in the Roma No. 4 bore, and the absence of flow while the water column stood in the bore, is a practical illustration of the necessity in boring, either for gas or oil, of so constructing the bore that all upper flows of water can be absolutely shut off from the interior of the bore, so that the pressure on any stratum giving indications of gas or oil may be taken off that stratum by bailing the bore, without any fear of incursion of water from higher strata. If such waters have access to the bore they cannot be bailed so as to take the pressure of the column of water in the bore off the productive stratum, and if the pressure of the gas or oil should happen not to exceed that of the water above it, no flow of either gas or oil can be induced. This is a well-known maxim in boring for gas or oil, but it is very often neglected by those who think that there is nothing more to be considered in designing a bore to prospect for oil than in designing a bore for water.

Petrol Content of the Gas.

The illuminating value of the gas at Roma, measured some twenty years ago, was given at 24 candle-power, and, as the candle-power of methane is only 5, it was quite evident that the gas had constituents in it other than methane. The analysis, though by no means precise, showed that these other constituents were mainly hydrocarbons, and it was from these facts, and the known high illuminating value of even small proportions of the higher hydrocarbons which form the constituents of petrol, that it was judged that the Roma gas contained vapour of the petrol constituents, and which led to arrangements being made with Mr. Henderson, Government Analyst, to test the amount of these constituents present. Mr. Henderson, in his preliminary tests, has already found 1.2 pints of petrol per 1,000 cubic feet of gas, and with more suitable adjustments of his pressure and temperature will, no doubt, get higher results. In America, large quantities of petrol were profitably made from gas carrying no more than 1 pint of petrol per 1,000 cubic feet of gas, while petrol was selling at 5d. per gallon. There is

little doubt that, in this gas at Roma, the State has an asset that can at any time be turned to profitable account, even if oil should never be found. It may not be considered advisable, however, to do so until a market can be found for the residual gas.

Estimates published by the Bureau of Mines, United States of America, in 1919, show that the capital expenditure on an absorption plant to treat 6,000,000 cubic feet of gas per diem is less than £1 for every 300,000 cubic feet per annum. With an extraction of only 1 pint per 1,000 cubic feet, the gross return per annum for each 300,000 cubic feet would be 300 pints of petrol, worth in Australia to-day some £7. The running expenses should absorb only a small proportion of this return, as all fuel for power and distillation would be available from a small proportion of the residual gas, and labour and superintendence costs would be low. There is little doubt, therefore, of the commercial possibilities of the extraction of the petrol, provided the supply of gas is large; and, as shown above, this condition seems to be fairly well assured.

Wood Distillation.

By A. J. HALL, B.Sc.

The dye industry is vitally connected with coal-tar distillation, and in recent years this connexion has been widely discussed. There are few dyestuffs that are not in one way or other derived from coal and its by-products. But coal is not alone in providing the dye manufacturer as well as the dyer with useful substances. Wood is an important raw material. By the dry distillation of wood, many useful by-products are obtained, and until further synthetic methods are discovered the production of such substances as methyl alcohol and formaldehyde will depend on this industry. At present, wood distillation is to a large extent supplying the demand for acetic acid, acetone, methyl alcohol, sodium and calcium acetates, formaldehyde, and charcoal. To a smaller extent wood yields several chemicals of value in medicine.

A Complex Substance.

Wood itself is a complex cellulose substance which will obviously have a composition dependent on its source. Hard woods are essentially different from soft woods. Cellulose and lignin are the chief constituents of wood. The various processes in paper manufacture are carried out with the object of separating these two substances, and at present the lignin liquors are a waste product which is awaiting a useful application.

England is not a country rich in timber, and, consequently, the greater proportion of wood distillation plant is situated abroad. Before the war, Germany carried out a great deal of wood distillation, and this industry was especially flourishing there.

Wood always retains a certain amount of moisture, and in the distillation it is customary to employ the wood in its ordinary air-dry condition. It will be noticed from the average composition of wood that no nitrogen products are present. Hence there are no nitrogeneous substances among the products of distillation. In the carbonization of bones, which contains a large proportion of nitrogen, a considerable amount of methylamine is obtained. In wood distillation hydroxy bodies as methyl alcohol are obtained. The average composition of dry wood is:—

Carbon	50.00	per cent.
Hydrogen	6.00	" "
Oxygen	42.75	" "
Ash	1.25	" "

It is but natural that attempts have been made to establish a relation between the final by-products and the original constituents of the wood. So far it would seem that, while both the cellulose and lignin give rise to carbon, acetic acid, and tar, the lignin differs from the cellulose by decomposing into less oxidized bodies such as methyl alcohol and acetone. Of course, no separation of the cellulose and

Extract from *The Dyer and Calico Printer*, 1st October, 1920.

lignin is effected before distillation, so that a mixture of all these by-products is obtained. In wood the proportion between these two essential constituents is variable, so that the wood distillate will also vary.

Distillation.

The distillation is carried out in large chambers whose construction varies at different works, while the condensation of the distillate is effected in water-cooled coils by the usual methods. A suitable quantity of the wood is introduced into the distillation chamber and then heated to about 270 deg. C. At this point the reaction becomes exothermic, and so much heat is evolved that further heating is unnecessary, and the reaction proceeds of itself. The liquid distillate which is collected is known as crude pyroligneous acid, and it contains all the by-products which have subsequently to be separated. But not all the products of distillation are able to be condensed. A considerable proportion are gaseous, and these are used in the heating of the distillation retort, thereby effecting a saving of fuel. The residue in the distillation chamber is wood charcoal, and is ground up and is then ready for the market.

The following indicates the average amounts of the crude products obtained by the dry distillation:—

Carbon (wood charcoal)	26.0 per cent.
Crude pyroligneous acid	47.5 " "
Non-condensed gases	26.5 " "

Of these, the crude acid is the most important as regards the dyeing industry. It consists of:—

Acetic acid	7.0 per cent.
Methyl alcohol and acetone	3.5 " "
Tar and impurities	8.5 " "
Water	81.0 " "

so that it can be readily seen that acetic acid is its most important constituent.

In working up the crude acid, the distillate is first allowed to settle, and it can then be separated from a large proportion of the tar. But not all, since some of the tar exists in a state of an emulsion. Complete separation is effected in the next process in which the crude pyroligneous acid is distilled. The distillate is generally absorbed or added to milk of lime. This serves to fix the acetic acid as calcium acetate, and also hydroylses any esters that may have formed. Methyl acetate, which is always present, is decomposed into methyl alcohol and acetic acid.

Lime Liquors.

The lime liquors are again distilled. The calcium acetate, being non-volatile, remains in the "still" residue, while the distillate contains the methyl alcohol, acetone, and a few other substances. Acetic acid, calcium acetate, and sodium acetate are obtained by treatment of this "still" residue. The liquid is concentrated and finally evaporated to dryness. A solid is obtained, which is known as brown acetate of lime.

It may be sold as such or further converted into acetone. Acetate of lime usually contains 80 per cent. of calcium acetate. When sodium acetate is required, and this has become an important product nowadays in the manufacture of acetic anhydride, the distillate from the crude pyroligneous acid is absorbed in a solution of sodium carbonate instead of milk of lime. The volatile constituents are distilled off and the residue is concentrated and finally evaporated to dryness. A considerable amount of organic impurities which are always present give the product a brown colour, so that it is heated to 320 deg. C. in order to destroy the foreign matter. The crude sodium acetate as thus obtained is further purified by dissolving in water and recrystallizing.

Acetic Acid.

The greatest proportion of the calcium acetate is converted into acetic acid. It is mixed with 95 per cent. sulphuric acid and distilled under reduced pressure. The crude calcium acetate is never free from impurities, and these react with the sulphuric acid to liberate oxides of sulphur. Hence by distilling under reduced pressure, the temperatures reached are lower, and in consequence the amount of sulphuric acid which is decomposed is greatly reduced. The strength of the acetic acid obtained varies with the type of still-head used. First runnings are from 25 to 50 per cent. But for the production of glacial acetic acid a second distillation is necessary, and an efficient rectifying column must be used. Weak acetic acid as obtained from wood products is frequently yellowish in colour. This is due to the presence of sulphur compounds formed during the distillation. Sulphur dioxide is often present in small quantity, and may be detected by its reducing action on a dilute solution of potassium permanganate.

The distillate obtained from the milk of lime liquors has the following composition:—

Methyl alcohol	70 per cent.
Acetone	16 ,, ,,
Aldehydes	6 ,, ,,
Water	8 ,, ,,

A separation of the constituents is effected by fractional distillation. The most important substance thus obtained is, of course, the methyl alcohol. Most of the uses for methyl alcohol are such that no ketone must be present. Thus in the production of the monomethyl and dimethyl anilines, where aniline hydrochloric acid and methyl alcohol are heated together in an autoclave under pressure, any acetone which may be present would react with the aniline to form an insoluble compound, and at the same time triphenyl methane by-products would be formed. Acetone would also be an undesirable impurity in methyl alchol which is to be used for the production of formaldehyde. So that the fractional distillation has to be carefully carried out to obtain a methyl alcohol containing not more than .1 per cent. acetone.

It will thus be seen that directly from wood distillation, acetic acid, methyl alcohol, and acetone are obtained. But the same industry usually carries on the related manufactures of formaldehyde from methyl alcohol and acetone from calcium acetate.

Acetone.

In the manufacture of acetone, calcium acetate is decomposed at a high temperature.

$$\underset{\text{Calcium Acetate}}{Ca(CH_3COO)_2} = CaCO_3 + \underset{\text{Acetone.}}{(CH_3)_2CO}$$

The calcium acetate is placed in layers on shallow steel trays and introduced into suitable retorts heated by gas. At about 300 deg. C. decomposition takes place, and the evolved vapours are condensed in water-cooled coils. The distillate is not pure acetone, since numerous side reactions take place. Purification is effected by fractional distillation.

When a very pure acetone is required, use is made of the ability of ketones to form sparingly soluble compounds with sodium bisulphite.

$$\left.\begin{matrix} CH_3 \\ CH_3 \end{matrix}\right\} CO + NaHSO_3 = \left\{\begin{matrix} CH_3 \\ CH_3 \end{matrix}\right\} C \begin{matrix} OH \\ NaSO_3 \end{matrix}.$$

The crude acetone is mixed with a concentrated solution of sodium bisulphite, and after standing some time, crystals of the acetone bisulphite compound separate out. These are filtered off, treated with an alkali, and the product distilled in order to obtain a pure acetone.

Formaldehyde.

Formaldehyde is a very important substance, and its uses are rapidly being increased. In the manufacture of dyes, it is employed largely in connexion with the triphenylmethane dyestuffs, such as magenta. It is used in the production of synthetic indigo. A large number of artificial resins are produced by condensing formaldehyde with phenol and its homologues. The condensation product between resorcinol and formaldehyde serves to fix basic dyes in textile printing processes. With gelatine, formaldehyde forms an insoluble compound, and this is made use of in a well-known method for waterproofing textile fabrics. Moreover, it is generally well known that most direct dyes are made considerably faster by an after-treatment with a dilute solution of formaldehyde. Finally, in the dyeing of cotton-wool unions with sulphur colours, a preliminary treatment of the wool with formaldehyde helps to preserve it against tendering by the strongly alkaline dye liquor. Formaldehyde has a growing importance.

When methyl alcohol is passed over suitable catalysts at a high temperature, partial oxidation takes place. Professor Bone has carried out numerous researches in this connexion. By controlling the oxidation it is possible to insure that a large proportion of formaldehyde is formed.

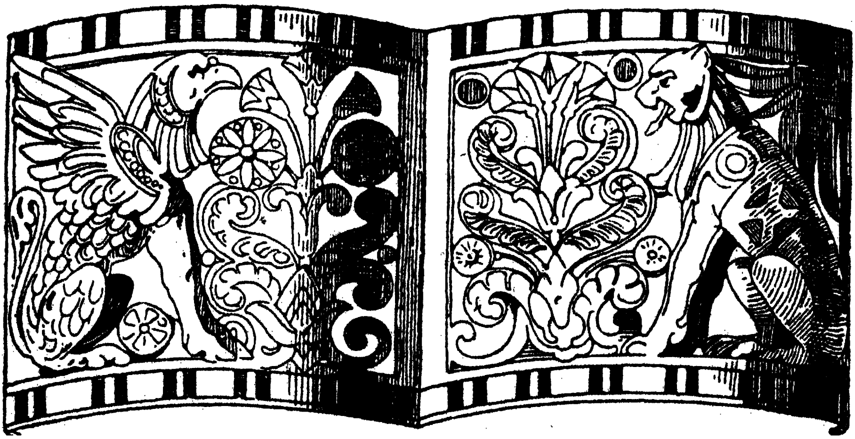
$$\underset{\text{Methyl alcohol}}{CH_3OH} + O = \underset{\text{Formaldehyde.}}{H.CHO} + H_2$$

In the process of manufacture the catalyst usually consists of rolls of copper netting. Methyl alcohol is sprayed with hot air over the catalyst which is maintained at a temperature of about 400 deg. C. The proportion of air to methyl alcohol must be carefully regulated. Air, of course, is the cheapest source of oxygen. But it is not possible

to employ the theoretical proportions because of the danger of possible explosions. It has been found that this danger can be completely avoided if an excess of methyl alcohol be employed, and this means that methods for recovering the excess have to be used. The gases, after passing over the catalyst, are led to a fractional condensing apparatus. Formaldehyde is more readily condensed than methyl alcohol, so that by maintaining the first condenser at a suitable temperature nearly pure formaldehyde is obtained. By means of a second condenser the methyl alcohol can be recovered.

The process is a continuous one: a mixture of air and methyl alcohol entering at one end of the plant while formaldehyde is obtained and excess of methyl alcohol is recovered at the other end.

Present conditions indicate that no attempt is being made to replace the timber which every year is being consumed. The paper pulp industry consumes so much timber that the scarcity is felt even now. It is suggested that flax—not the type used for linen manufacture—should be used in paper mills. Obviously, then, at some future date, wood distillation will have to be discontinued. The demands for acetic acid, acetone, and formaldehyde will then have to be satisfied by synthetic processes.



National Institute of Agricultural Botany.

In delivering his presidential address to the Botanical Section of the British Association for the Advancement of Science, Sir Daniel Morres said, "During the great war which has now happily been brought to a close, it has been abundantly made clear that in botany, as in other applied sciences, we must rely, in future, less on chance, individual effort, and initiation." Some time before these words were spoken, a movement was on foot to establish a National Institute of Agricultural Botany, which was especially designed to co-ordinate the work of the private individual, the Plant Breeding Institute, and the seed merchant.

The plant breeder is usually a person with neither sufficient means nor land to grow his product on a commercial scale for himself. At present, he has either to distribute his seed in small lots to farmers for trial, or he has to sell the whole of his stock to seed firms and leave its development to them. The first method is clumsy; the seed is very likely to become mixed, and the rate of dissemination is very slow. The second method is more rapid, but results in concealing the name of the originator from the public. In cases where it is not a private individual but a firm or institute which produces the new variety, it is easier for publicity to be obtained; but, even here, lack of funds and a small staff often hamper the work. The proposed National Institute of Agricultural Botany should, to a great extent, overcome these difficulties, as its main functions will be as follows:—

1. To receive stocks of seeds of new varieties which the directors regard as having been sufficiently tested. These will be grown on a commercial scale and put on the market.
2. To maintain, by trials, pure stocks of the main varieties of cereals and other plants, and by occasionally re-selecting this stock to make seed of undoubted purity and high quality available to the seed merchants.
3. The Institute will certify to the purity of stock in the hands of farmers and seedsmen when asked to do so.

Other points, such as the registration of varieties and control of the tremendous number of synonyms, will also be taken up. It can be seen from this statement of functions that the Institute will be responsible for arriving at and maintaining a high standard of quality and purity in the seed supply of British merchants to both home and foreign buyers.

As soon as the Institute has time to get into proper working order, probably a matter of two or three years, the results should be easily observable. The improvement of the agricultural crops will no longer be left to chance, but will be the definite goal in front of a chosen body of capable men, while individual effort and initiation will be encouraged and given every opportunity to achieve success.

The Institute is designed to supply the wants of the United Kingdom, but its influence on the quality of seed exported will be as noticeable in Australia as elsewhere.

In regard to our own crops, the State Agricultural Departments are doing a great deal for the production of new varieties and the maintenance of a high quality of seed. There is, at present, no system for the registration of new varieties, but the Seed Improvement Committee of the Commonwealth Institute of Science and Industry is working on the classification of the varieties of cereals and the control of the number of synonyms.

—E.A.

The important requisites for industrial research are often unconsidered by manufacturers, who, in endeavouring to select a research chemist, are likely to regard every chemist as a qualified scientific scout. The supply of men capable of working at high efficiency as investigators is well below the demand; and chemists having the requisites and spirit of the researcher are indeed difficult to find by ones experienced in the direction of research. All research professors know that the finding of a skilled private assistant—one who possesses not only originality, but also sound judgment and intellectual honesty—is not easy, because it frequently involves the gift of prophecy on the part of the searcher. It has been truly said that the "seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

—RAYMOND F. BACON.

"The Administrator of Industrial Research Laboratories."

Steel Cylinders for Compressed Gas Containers.

The manufacture of industrial gases, such as oxygen, carbon-dioxide, and anhydrous ammonia, has now reached considerable dimensions in Australia, and the Institute has received inquiries regarding processes for the manufacture of the steel cylinders which are used to contain such gases, but which are not at present made in the Commonwealth.

The weldless cylinders used for this purpose are generally solid-drawn from a disc of steel. In drawing the cylinders, the process in England is a horizontal one, and the cylinders are drawn partly cold and partly hot. In America, the process is entirely hot—annealing taking place as necessary—the ram working vertically downwards. It is stated that this method has the great disadvantage that the scale formed causes fluting of the exterior surface of the cylinder, and it has recently been suggested that, if the ram were arranged to work upwards instead of downwards, the scale would not free itself automatically, and would result in a polished cylinder, free from external fluting. The dies are lubricated with a mixture of graphite and tar.

Generally speaking, the manufacture of cylinders is a simple problem from a practical point of view. Assuming that the plates are delivered in squares, the first operation is to shear off the corners so as to make a circular disc. This is done "hot" in one operation. The disc is then passed on to a series of vertical presses—three or four in number—in which, by means of die-plates and rams of gradually reducing diameter, it is reduced by stages to something like elongated thimble form. By that time, the steel is too cold to work, and has probably become hardened somewhat as the result of the drawing-down process to which it has been subjected. It has therefore to be re-heated and annealed. In the re-heating process, care must be taken that the temperature of the furnace does not reach the "scale point." In any case, the process should be carried out in a "reducing" flame by means of producer gas and a properly regulated air supply.

During the time that the partially drawn cylinders are being re-heated, the dies and rams of the presses are being changed. The partially drawn cylinders are then subjected to further pressing, the process being repeated until they have been drawn down to the required diameter. They are then allowed to cool. The next operation is to cut them to length. This is done with an ordinary parting tool, in a lathe. The cylinder is then inspected for obvious flaws, both inside and out, and the walls are callipered to establish uniformity of thickness, after which the cylinder is ready for "necking down".

The necking down of the cylinders is performed by a series of small steam hammers fitted with suitable swage blocks. For this process, it is not usual to heat more of the cylinder than is absolutely necessary, the butts remaining black. Swaging is carried out till the neck is closed. No welding takes place, as the temperature is too low. The

cylinder is then once more heated up and carefully annealed. When cold, it is again put in a lathe and the neck is turned, bored, and tapped. The cylinder is now ready for testing.

The question of the final and proper annealing of the cylinder previous to testing is of prime importance. The actual temperature is naturally dependent on the composition of the steel, and is so definite that there is no scope for more than about 10 degrees F. variation either way. It can only be established by experimenting.

A plant with 3 presses and 3 steam-hammers would be capable of turning out from 300 to 500 cylinders per week, working "days only," after the preliminary drawing operations have been carried out. In other words, during the period, say one week, occupied with the initial drawing and shaping of the cylinder, there would be no output. The dies and rams would then be changed, and the ensuing week would be productive. For continuous output, the plant would obviously have to be doubled.

Though reliable estimates of cost are not available, it is probable that the cost of such an installation, with buildings, gas producer, furnaces, presses and dies, lathes, steam-hammers, testing plant, hydraulic accumulator, and all necessary accessories, would amount to upwards of £50,000. This at once establishes a considerable overhead charge for depreciation, which alone would amount, at 10 per cent., to £1 per cylinder on an output of 5,000 cylinders per year.

As regards the number of cylinders required for a given gas plant, experience in England and America shows that a cylinder is filled about ten times a year on the average of the whole lot. Thus, a plant, to turn out 1,000,000 cubic feet of oxygen annually, would require about 1,000 cylinders, each of 100 cubic feet capacity.

G. L.

Scientific and Technical Societies.

LINNEAN SOCIETY OF NEW SOUTH WALES.

At the October meeting, the President announced the receipt of a very valuable addition to the library, of books and pictures bequeathed to the Society by the late Mr. F. M. Clements, F.L.S., F.Z.S.

PAPERS READ.

1. Notes on Australian *Tabanidæ*. By Eustace W. Ferguson, M.B., Ch.M., and Gerald F. Hill, F.E.S.

The paper deals mainly with synonymy, the results being given of comparison of specimens with the types of Australian *Tabanidæ* in the British Museum and in the Australian Institute of Tropical Medicine. Seventeen species belonging to five genera are dealt with, one species being described as new.

2. Studies in Australian Lepidoptera—*Liparidæ*. By A. Jefferis Turner, M.D., F.E.S.

In Australia, the family *Liparidæ* is represented by 60 species belonging to 18 genera, of which 2 genera and 10 species are described as new in this paper.

3. Descriptions of new forms of Butterflies from the South Pacific. By G. A. Waterhouse, B.Sc., B.E.

One species from Fiji, and six new subspecies from Fiji (three), Lord Howe Island (two), and the New Hebrides (one) are described as new.

4. A new Avian Trematode. By Eleanor E. Chase, B.Sc. (Communicated by Professor S. J. Johnston, B.A., D.Sc.)

A species of *Holostomum* is described as new. The specimens described were obtained from a white-fronted heron, *Notophoyx novæ-hollandiæ*, at Terrigal, New South Wales.

5. Cyanogenesis in Plants. Part iv. The Hydrocyanic Acid of *Heterodendron*—a fodder plant of New South Wales. By J. M. Petrie, D.Sc., F.I.C., Linnean Macleay Fellow of the Society in Biochemistry.

The foliage of *Heterodendron oleæfolia* was much used for cattle-feeding during the drought. Chemical examination of the leaves shows them to contain a cyanogenetic glucoside yielding, when hydrolysed, 0.328 per cent. of hydrocyanic acid. The plant is therefore one of the most poisonous cyanogenetic plants known, yielding more than twice as much hydrocyanic acid as bitter almonds. One ounce of the air-dried leaves forms a lethal amount for one sheep. The leaves are invariably found to be deficient in enzyme, and require the addition of emulsion in the estimation to bring about the complete decomposition of the glucoside.

6. Studies in life-histories of Australian Diptera Brachycera. Part i. *Stratiomyiidæ*. No. 1. *Metoponia rubriceps* Macquart. By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

Very little work has been done, in any part of the world, on the early stages of the Brachycera; many soil-inhabiting, dipterous larvæ, mostly belonging to the Brachycera, have been collected and reared through to the imago or to the pupal stage. The present paper is the first of a series dealing with this work and gives a detailed account of the life history of *Metoponia rubriceps* Macquart. It is also accompanied by a historical review of published accounts of early stages of the *Stratiomyiidæ*, a list of the species whose earlier stages have been observed, and a comprehensive bibliography.

NOTES AND EXHIBITS.

Mr. W. W. Froggatt exhibited a series of flies from India, including *Chrysomyia bezziana* Villeneuve, *C. flaviceps* Walker, *C. rufifacies* (= *C. albiceps* W.), *C. nigriceps* Patton, *Lucilia serenissima* Fabr. and *L. craggii* Patton. A number of these cause cutaneous myiasis in man and animals in India. Also specimens of *Bibio imitator* from suburban gardens.

Mr. G. H. Hardy exhibited a pair of flies, *Chrysomyza aenea* Fabr., taken in a garden at Haberfield, 28th March, 1920. The species is new to the Australian fauna.

Mr. Waterhouse exhibited the first specimen of *Heteronympha solandri* Waterh. reared from the egg. The history of the specimen is that a female was caught at Mt. Kosciusko on 15th February, 1920, and on dissection of the abdomen four eggs were obtained; only one was fertile, and this emerged on 28th February and was looked after very carefully; the larva pupated at Sydney on 8th September, and a male emerged on 10th October, about three months earlier than the usual time of appearance at Mt. Kosciusko. The female parent, the cast larval heads from the 2nd, 3rd, and final instars and the pupal skin were also shown.

Mr. E. Cheel exhibited a series of specimens collected in the coastal district from Sydney to the Upper Clarence, and on the higher elevation at Hill Top and on the Blue Mountains, including *Boronia ledifolia* J. Gaz.; *B. ledifolia* var. *rosmarinifolia* (B. rosmarinifolia A. Cunn.) from Hill Top (E. Cheel, July, 1914), Bell (Miss H. Gregson, Sept., 1914), Mount Wilson (J. H. Maiden, Dec., 1914), near Cowan Station (W. F. Blakely and D. W. C. Shiress, Sept., 1919), and specimens with double flowers from Hill Top (E. Cheel, August, 1915); *B. ledifolia* var. *triphylla* (B. triphylla Sieber) from Port Hacking (W. Slade, August, 1914), Kurrajong Heights (H. Dixson, September, 1897), National Park (M. Bell, August, 1901), Woy Woy (Miss A. C. Johnstone, July, 1916), and double-flowered specimen from Lindfield (E. G. Jacobs, August, 1913); *Boronia pinnata* Sm. with double flowers from Redfern (Mrs. Boyce, November, 1900) and Hornsby (W. F. Blakely, April, 1914): *Eriostemon lanceolatus* Gaertn. with pure white flowers, Tomago (Lady Windeyer, September, 1903), Rose Bay (October, 1906), Nelson's Bay (J. L. Boorman, August, 1911); *E. Crowei* F. v. M. with pure white flowers from Hornsby (W. F. Blakely and D. W. C. Shiress, Feb., 1920); *Kennedya rubicunda* Vent. with greenish-white flowers, Wahroonga (M. S. Barnett, Sept., 1920); and *Ceratopetalum gummiferum* Sm. with white flowers from between Hornsby and Durall (W. J. Pitty, Dec., 1919).

Mr. Cheel also exhibited on behalf of Miss A. A. Brewster specimens, and a chart, showing doubling of flowers and deterioration of the stamens of *Eriostemon lanceolatus* from Maroubra (October, 1920). In one specimen the stamens had multiplied to 16; in the more changed flowers the number varied from 1 to 4, and in one case there was left only a single anther seated on one of the inner petals. In two flowers the pistil was absent and five small petals were present in place of the carpels; in another the five degenerated carpels were partly green and partly pink.

Mr. John Mitchell exhibited a series of Silurian and Devonian brachiopods from New South Wales.

ROYAL SOCIETY OF QUEENSLAND.

At the September meeting, Mr. H. A. Longman, F.L.S., exhibited a specimen of the Phyllopod, *Lepidurus viridis* Baird, which had been found in a "melon hole" at Tara, Darling Downs, and forwarded to the Queensland Museum by Mr. Wm. Hewins. Although well known in other Australian States and in New Zealand, this is apparently the first record for Queensland. Specimens referring to the allied species, *Apus australiensis*, Spencer and Hall, had been sent in recently from Barcarolle, W. Queensland, by Mr. F. L. Berney. Mr. Longman briefly referred to the way in which the eggs of these Phyllopods retain their vitality when transported in mud adhering to the feet of aquatic birds.

Dr. J. Shirley, F.M.S., exhibited a flowering specimen of *Ginkgo biloba*, L., showing male cones or rather catkins. This tree has leaves like the fronds of the maiden-hair fern, and so has been called the maiden-hair tree. A synonym is *Salisburia adiantiæfolia*. It is a native of Eastern Asia, and may be found planted about Buddhist temples in China and Japan. Recently it has been stated that its true habitat is in one of the ranges of E. China. Like plants of the order *Cycadaceæ*, it is remarkable for producing spermatozoids, by which the ovules of the female cone are fertilized. The fruit is nut-like, one-seeded, and edible.

Ten fossil plants, belonging to Gingkoales, have been reported from the Ipswich Beds of Denmark Hill, Queensland. Four are species of *Ginkgo*, and four belong to *Baiera*, and two are classified under *Stachopitys*.

Professor H. C. Richards, D.Sc., exhibited a hemispherical pebble of chalcedony from near Tripoli at the foot of Lebanon, Syria. The specimen was found by Mr. V. G. Harris, a member of the Australian Imperial Force.

The specimen, which was one of many commonly termed "petrified olives," is hemispherical in shape, and has the appearance of one-half of a biaxial elliptical pebble which has been cut in two and polished on the sliced surface. It has a diameter of 35 mm. each way and a depth of 15 mm. The pebble has four or five concentric layers of chalcedony forming an outer coating which is about 5 mm. thick.

Mr. Harris states that the pebble is in its natural condition, that it was found loose on the surface of the ground, that he handled several specimens of the same size and shape from the same locality, and saw others further south, near Beelah.

The polished surface has the characteristics of a wind-polished surface with minor dimples, pits and grooves, as one might expect, and the edges of the "polished" area are quite sharp.

The only feasible explanation that could be offered as to the origin of a number of pebbles of this shape is that it formed portion of a conglomerate which has been sheared so as to cut through the pebble, and that the sheared surface had been subjected to wind erosion following on which the pebble had been weathered out of its matrix. This explanation might hold for an isolated pebble, but cannot be offered as the cause of frequent specimens of a similar shape in different localities.

Professor H. J. Priestley, M.A., delivered a lecture entitled "The Einstein Theory."

ROYAL SOCIETY OF TASMANIA.

At the October meeting, Mr. L. Rodway, C.M.G., read a paper on "Additions to the Fungus Flora of Tasmania." Several new and interesting species of fungi were described. The value of the study of botany was dwelt upon by the lecturer in his introduction. He pointed out that in any community such as Tasmania, where the future largely depends upon agriculture, the study of botany was essential. It was to be regretted that up to the present this study had been absolutely neglected, even at the University. Independent of the injury done by some parasitic fungi to our crops and forests, fungi were of the utmost importance to the well-being of the earth. Their principal work consists of decomposing dead vegetable matter and bringing the soil into a fit state to afford food for plant life.

Short lecturettes on the subject of "Education for Community Life" were given by Messrs, Johnson, Copland, Fletcher, Dechaineux, and Dickenson.

LINNEAN SOCIETY OF NEW SOUTH WALES.

Papers Read.

At the November meeting the following papers were read:—

1. A revision of the Chiromyzini (Diptera). By G. H. Hardy.

A study of the genus *Metoponia* and its allies, following on Miss Irwin Smith's study of the larva of *M. rubriceps* Macquart. Attention is drawn to the fact that various genera hitherto proposed were founded on venation characters in accordance with the usual custom of grouping the *Stratiomyiidæ*, but it is pointed out that such a treatment is impossible with the species dealt with in this paper, and also that it will have to be abandoned as a main factor in grouping other species of *Stratiomyiidæ* before a natural classification of the family can be attained.

2. Some new Brachiopods from the Middle Palæozoic Rocks of New South Wales. By John Mitchell.

From rocks of Upper Silurian age at Bowning, Hatton's Corner, and near Molong, one genus and four species are described as new; *Retzia salteri* is

recorded from Limestone Creek, in rocks also of Upper Silurian age. The two species, *Merista plebeia* and *Orthis striatula*, typical Middle Devonian forms in Europe and North America, are described from Tulcumbah, near Carroll.

3. Nematode Parasites of the Domestic Pigeon (*Columba livia domestica*) in Australia. By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

The only Nematode hitherto recorded from this host in Australia is *Ascaridea columbæ* Gmelin from both New South Wales and Queensland. Records of two further species are added and a new generic name is proposed for *Strongylus quadriradiatus* Stevenson.

4. A few notes on the Botany of Lord Howe Island. Sixth paper. By J. H. Maiden, I.S.O., F.R.S., F.L.S.

This brief paper supplements existing information in regard to hybrid Howeas, they having been under cultivation in the Sydney Botanic Gardens for a number of years. There are notes on indigenous plants hitherto unrecorded, of which *Adiantum formosum* R.Br. is the most important. A number of records of introduced plants are also given.

NOTES AND EXHIBITS.

Mr. Fred Turner exhibited and offered observations on a specimen of *Lolium temulentum* Linn., which he had received for determination from Mr. R. Baird, Multagoona, Darling River, who had never hitherto seen it growing in the district. The seeds of this exotic grass are considered injurious, and if eaten are said to produce drowsiness, headache, and vertigo. According to Sir J. D Hooker and the Rev. Canon Tristram, "this species is identical with the 'Tares' of Scripture, and is one of the worst weeds in the wheat crops of Palestine, and the only grass with a poisonous seed."

Mr. W. W. Froggatt exhibited specimens of the Bag Shelter or Boree Moth, *Teara contraria*, showing the masses of eggs covered with the down off the tips of their bodies. One of the egg masses contained a number of eggs of a parasitic moth, the larvae of which feed upon the eggs of the Boree Moth and pupate under the cover of the egg down. The larvæ of this Bag Shelter Moth every year strip the foliage from thousands of Boree trees, *Acacia pendula*, one of the most valuable fodder trees in Australia.

Mr. G. A. Waterhouse exhibited *Tisiphone rawnsleyi* ♂ and *T. abeona* ♀ which he had paired, together with 3 ♂ and 2 ♀ obtained from this cross and also two small families obtained by pairing these first generation specimens. One family consisted of 3 ♂, 1 ♀, and the other of 1 ♂, 2 ♀ Also four specimens of the first generation obtained by crossing *T. abeona* ♂ with *T. rawnsleyi* ♀. Also *Heteronympha mirifica* and *H. paradelpha* reared from larvæ, together with dead pupæ of both species.

Mr. H. J. Carter exhibited (i) specimens of each of the six Australian genera of *Chalcophorimæ* (*Buprestidæ*). These six genera were at an earlier period all classed as *Chalcophora*, though they are clearly differentiated in modern work; (ii) specimens of three closely allied *Cyphogastra*, concerning two of which there is some confusion in Kerreman's "Monographie"; (iii) *Cyrioides sex-spilota* Carter recently collected by Mr. H. W. Brown on the Johnstone River, Q.; (iv) an example of a new genus taken by Dr. E. W. Ferguson at Port Macquarie; and (v) a new species of *Stigmodera* from the Blue Mts.

Dr. A. B. Walkom exhibited a number of seeds associated with *Glossopteris* in rocks of Permo-Carboniferous age from Three-mile Creek, on the Bowen Coalfield, Queensland.

Mr. J. J. Fletcher exhibited specimens of *Persoonia lucida* R.Br., from the Lane Cove district, being portions of the only two plants, both solitary, he had ever seen growing. The opinion was expressed that this species needs further investigation.

The Annual General Meeting, together with the next Ordinary Monthly Meeting, will be held on Wednesday, 30th March, 1921, at 7.30 p.m.

THE ROYAL SOCIETY OF QUEENSLAND.

At the October meeting, Mr. W. E. Appleby and Dr. E. O. Marks were elected to ordinary membership of the Society.

Professor H. C. Richards, D.Sc., delivered a lecture entitled "The Hawaiian Islands." The lecturer gave an account of the recent Pan-Pacific Scientific Conference at Honolulu, and made some remarks on the origin, structure, and character of the Hawaiian Islands. The lecture was illustrated by a large series of excellent lantern slides, a number of hand-coloured photographs of the active volcano of Kilauea, and specimens collected from the recent lava flows.

THE MICROSCOPICAL SOCIETY OF VICTORIA.

The twelfth Annual General Meeting of the Society was held at the rooms on Monday evening, 27th September, 1920. During the year there were held eleven general meetings, at which nine interesting papers were read; and excursions made to Cheltenham, Mont Albert, Ringwood, Fitzroy Gardens, Beaumaris, River Yarra, the Zoological and the Botanical Gardens. The Committee met eleven times during the year. The Hon. Treasurer pointed out that owing to the increase in the cost of printing, postage, and lift expenses, the financing of the Society's activities has been difficult, but the Committee deems an increase in annual subscription undesirable. Therefore, it solicits members to endeavour to increase the membership list, and it desires to thank all those who have in various ways contributed their services to the Society.

The President in his address referred to the tendency, as a result of the recent upheaval of nations, for science to be more helpfully linked with the economic side. At the same time it is necessary for those in authority to have a clear knowledge of the use of research and not to hamper the man of science with a prohibitive taxation on his correspondence and apparatus.

The various fields of microscopic research open to members was touched upon, the speaker referring to a want of workers in the domain of the microzoa, the smaller insects, and many other rather neglected subjects, some of which have never been examined from the Australian stand-point.

In concluding his remarks, Mr. Chapman gave a description of the principal forms of Guano and Phosphatic Rock from the microscopic point of view, a subject to which he has paid some special attention during the past few years, and illustrated his remarks by sketches of the chief types of structure on the blackboard.

ROYAL SOCIETY OF VICTORIA.

At the October meeting, the following paper was read:—"A Generalization of Elementary Geometry," by D. K. Picken, M.A.

The subject of the paper was an outstanding defect of generality in elementary geometry, associated with the ambiguity "equal or supplementary" in certain fundamental angle theorems. The appropriate principle of generality was first arrived at by the author of the paper, in a paper on "Simson's Line," read to the Edinburgh Mathematical Society, in May, 1914. Subsequent consideration had made it clear that the principles in question are basic to the elementary geometry of the Straight Line, of Parallels, and of the Circle, and are of wide applicability in the geometrical theory dependent on these.

A Lecture of "Giant Stars and Dwarf Stars," was delivered by J. M. Baldwin, M.A., D.Sc., of which the following is an abstract:—

"The amount of light received from a star determines its *apparent magnitude* (m), the ratio for two stars differing by one magnitude being 2.512. The *absolute magnitude* (M) is what the apparent magnitude would be if the star were at the standard distance of 10 parsecs, which corresponds to a parallax of 0.1 inches. If π is the parallax of a star in seconds of arc—

$$M = m + 5 + 5 \log \pi.$$

In this equation, m is not difficult to measure, and hence if π or M is determined the other can be found.

Russell took all stars for which fairly accurate values of π were available, and from the above equation computed M. Then plotting M as ordinate, type of spectrum as abscissa, he found:—

(1) All white stars are far brighter than the Sun.
(2) Range of brightness increases with redness.
(3) All faint stars are red.
(4) All red stars are very bright or very faint.

Adams and Kohlschütter found that the relative intensity of selected lines in the spectrum of a star depended on the absolute magnitude, and hence were led to a method of determining the absolute magnitude from measurements on the spectrum. M being determined, the equation gives π, and thus the parallax can be measured spectroscopically. This work brought out very clearly the division of the red stars into a very bright group and a very faint group, with no stars of intermediate brightness.

The absolute magnitude depends on mass, density, and surface brightness. The only information as to mass is obtained from binary stars, and for these the total range in mass is only from 10 times that of the Sun to ¼ that of the Sun. The surface brightness for stars with similar spectra must be nearly equal, and thus the average red star of the bright group, which gives out 1,000 times as much light as the average red star of the faint group, must have 1,000 times the surface and 30,000 times the volume of the latter. Hence the terms giant and dwarf. If the masses are equal, the densities will be in the ratio 30,000 to 1.

For special classes of stars the relative surface brightness can be obtained, and it is found that the very white stars give out 500 times as much light per unit surface as the very red stars. For the giant stars the density increases from the red stars to the white, while for the dwarf stars the density increases from the white stars to the red. As the giant stars contract and get hotter, the increase in surface brightness nearly balances the decrease in surface, and the stars remain nearly constant in brightness, as is actually found to be the case. After a limiting density is reached, cooling follows further contraction, and both surface brightness and surface decrease together, and a rapid diminution of light is the result. This also is confirmed by observation.

ROYAL SOCIETY OF SOUTH AUSTRALIA.

The Society met on 11th November, 1920, Sir Joseph C. Verco, M.D., F.R.C.S. (President), in the chair.

The Hon. Secretary reported that certain old documents referring to the origin and early history of the Society had been handed for safe custody to the Archives Department of the Public Library, where they would be catalogued. and be available at any time for reference.

It was resolved that the Society indorses the following two resolutions passed by the Section of Public Health and State Medicine of Australasian Medical Congress, held this year in Brisbane, viz.:—

> "8. That this Congress is of opinion that the time has arrived when a campaign of Preventive Medicine should be made real and effective, and that with the object of carrying out such an undertaking, and of fully utilizing existing agencies, the Commonwealth Government be approached and requested to appoint a Royal Commission to fully consider and report.
>
> That the *personnel* of such a Commission should contain a considerable percentage of unofficial medical practitioners representing various medical activities, and also representatives of local governing bodies."
>
> "9. That the Congress recognises the importance of preventing the extinction of wild life in Australia, both on grounds of scientific interest and of public health. It urges on the various States Governments the desirability of making reservations, biological areas in which the protection of the remarkable Australian animals may be adequate."

In this connexion, it was pointed out that, after a campaign which lasted for thirteen years, this Society had succeeded in obtaining the passage through Parliament of the Flinders Chase Act, establishing such a reserve in the western portion of Kangaroo Island, under the control of a Board on which this Society and the University of Adelaide were represented.

The President reported that the Council had made to Mr. F. R. Marston a grant in aid of research into the possibility of obtaining from azine precipitates samples of the pure proteolytic enzimes.

Numerous exhibits were tabled by fellows, including an aboriginal skeleton, showing mended fractures of thigh and arm, recently ploughed up on the land of Captain S. A. White, at Fulham, near Adelaide.

CORRESPONDENCE

COLLIE COAL.

To the Editor.

In an article under the heading of "Coal Economy," in September number of your Journal, there appears the following statement:—"For instance, there is the case of Collie (Western Australian) coal, which is not suitable for bunkering coal, owing to its liability to spontaneous combustion." It seems hard to kill out incorrect statements of this kind, which are constantly being repeated, either being copies from published statements made by those with a very insufficient knowledge of the nature of Collie coals, or are based on hearsay evidence. It is distinctly unfair to the coal industry, especially at Collie, that these statements should be reproduced to the detriment of the bunkering industry, which has for years past been built up in the face of criticism of this kind.

In the first place, it is not proper to speak of the coals in the Collie field as of one type. There are three distinct coals mined on that field. At one end of the field are the hard coals, with relatively high ash, represented by the Western Australian and Co-operative coal. At the other end of the field there occur the softer low-ash coals, such as that of Cardiff or Scottish coal. The intermediate between these two is the preparatory coal; intermediate not only in geographical position, but in many of its chemical and physical properties. Now, of the three classes of coal, it is only this middle one which can fairly be described as more liable to spontaneous combustion than other good-class merchantable bunkering coals. An examination of reported cases of spontaneous combustion of Collie coals shows that an enormous proportion of them occur with this coal. Both the hard and the soft coals in practical use, and under laboratory examination, are, at least, as free from liability to fire spontaneously as are, say, Newcastle and Maitland coal. It is unfortunate for the Western Australian coal industry that no check has been placed on the type of coal placed in the ships' bunkers. Fortunately, now there seems every prospect of amalgamation of the principal Collie mines, and this should result in preventing the condemnation of all the Collie coals by the bad behaviour of one of them.

Yours, &c.,

I. H. BOAS.

REVIEWS.

Modern Brickmaking, by Alfred B. Searle, pp. x +500, with 310 illustrations. London: Scott, Greenwood & Son, 8 Broadway, Ludgate Hill.—Since the first publication in 1911 of his work on the processes, machines, and kilns used in the brickmaking industry, a considerable amount of information relating to clay working has accumulated, and this has been included in the second edition. It constitutes most of the new matter now brought before the public. At the same time, however, the whole work has been revised, corrected where necessary, and partly re-arranged. Modern methods of manufacture, both in Great Britain and in Europe, are discussed; and the illustrations are of great value in explaining the operation of much of the machinery referred to. A careful perusal of the book should enable any person acquainted with the rudiments of the subject to follow the discussion of the various features dealt with, and to make use of such methods as are new to him.

A Treatise on Surveying, Vol. II., by R. E. Middleton, M.I.C.E., and O. Chadwick, M.I.C.E., London E.: F. N. Spon Ltd., 1920. p. viii. + 357.—In its original form, this book was the work of a number of authorities, each writing more or less independently, and with a very exact idea of the contributions from one another. This naturally resulted in certain defects, and in the present edition, Mr. M. T. M. Ormsby, Reader in Surveying at the University of London, has succeeded admirably in revising and bringing the previous edition up to date, and in removing these defects. The information contained in the first volume is sufficient to meet the requirements of students entering for the less difficult examinations in surveying, and of young engineers in countries already mapped; whilst the present volume supplies the additional information required for the more advanced examinations, and for work in unmapped districts, as well as serving as an introduction to the study of higher geology. The whole work has been re-arranged, and nothing of special value omitted. A great deal of new matter has been added. In particular, the following may be mentioned:—(*a*) A chapter on the History of Surveying, written by Mr. E. H. Sprague, A.M.I.C.E., Lecturer on Surveying at the Westminster Technical Institute; (*b*) The method of least squares has been explained, and several worked examples given; (*c*) The adjustment of the errors in a triangulation has been treated much more fully than before; (*d*) The number of worked examples has been largely increased. The additions enhance very considerably the value of the original work, which was prepared under the ægis of the Council of the Surveyors' Institution.

Model Aeroplaning: Its Practice and Principles, by V. E. Johnson, M.A. London E.: F. W. Spon, 1920. Pp. vi. + 257.—This is the second edition of a book first published in 1910. In an introduction, the author states that since that time great progress has been made in model aeroplaning, and he refers to the importance which he considers models are likely to play in the future development of aeronautics. In England, model aeroplaning has come into some prominence as a pastime, and a number of clubs for this purpose have been established. The Royal Aero Club has established a Kite and Model Aeroplane

Association, to the rules of which affiliated clubs must conform. Whilst it is true that in the early days model aeroplaning played a very important part in the development of aeronautics, in view of the great advances made in the knowledge of scientific principles, it is very doubtful whether the author's claims for its future importance can be justified. Of course, the study of the properties of aerofoils by the use of models in wind tunnels, such as is being carried out by the National Physical Laboratory and the Eiffel Laboratory, is of the greatest value, and has had very important results in evolving the most efficient wing sections for various specific duties; but that is a subject which is not dealt with in the present volume. The book contains little information that is of scientific value, such as is furnished in recent works on aeroplane design and construction, and the author does not, apparently, appreciate the fact that the study of aeronautics can only be successfully attempted by those possessing a good knowledge of mathematics and physics. To persons desiring to construct model aeroplanes for use as a pastime, the book will be of considerable interest and value.

Slide Rules, and How to Use Them, by T. Jackson, M.I.M.E. London: Chapman & Hall, 1920. Pp. 31. Prime, 1s. 6d. net.—One of the most striking developments in modern technical methods of calculation has been the enormous increase in the use of slide rules. In the present booklet, the principle of the rule and the main features of different makes are explained. The first eighteen pages deal with the ordinary pattern of "Grave" (or "Mannheim") slide rule and show how the different operations—multiplication, division, proportion, reduction squares and cubes, square roots and cube roots, logarithms, &c.—are carried out. The special markings found on one or other of the various makes are also explained. In the following pages, information is given regarding "log-log" rules, and some special rules, such as the "Fix," the "Rietz," the "Long-short," the "C.E.M.," the "Prof. Nestle," and the "Omnes" rules. In an appendix, particulars are given of the "watch form" calculator. The booklet will be of considerable value to engineering students in explaining the principles and methods of using slide rules. Its value would have been enhanced by the inclusion of an explanation of the "spiral" rule.

PUBLICATIONS RECEIVED.

Insects of Economic Importance, by G. W. Herrick. Macmillan & Co., New York. 1920.

Australian Quarantine Service: Commonwealth Serum Laboratories and their Work. 1920.

Turbine Steels: A research into their mechanical properties, by Dr. Hatfield, of the Brown-Firth Research Laboratories, and H. M. Duncan, B.Sc.

New Zealand Institute: Transactions and Proceedings for 1919, vol. 52.

Western Australian Forests Department: Report for 1918-1919.

Victorian Institute of Refrigeration: Proceedings of First (Annual) Conference. 1920.

United States Department of Agriculture, Bulletin No. 772.—The genera of grasses of the United States, with special reference to the economic series, by A. S. Hitchcock, pp. 307. 1920.

British Engineering Standards Association: Standard Specifications:—

No. 1 (revised July, 1920). Lists of British Standard Rolled Steel Sections for Structural Purposes.

No. 12 (revised 1920). British Standard Specification for Portland Cement.

No. 94. British Standard Specification for Watertight Glands for Electric Cables. 1920.

No. 97. British Standard Specification for Watertight Fittings for Incandescent Electric Lamps. 1920.

No. 100. British Standard Dimensions for Body Spaces and Frame Ends for Chassis for Private Automobiles. 1920.

No. 106. British Standard Specification for Electrically Heated Cooking Range (two sizes). 1920.

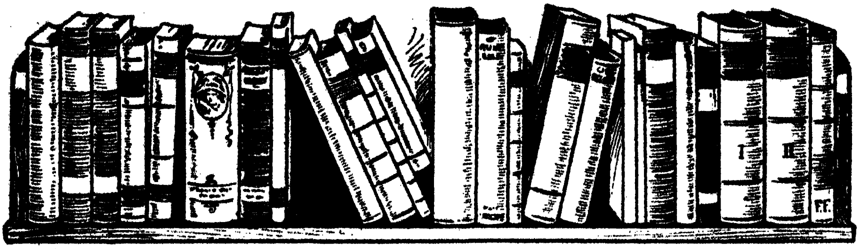
No. 131. Report on British Standard Forms of Notched Bar Test Pieces. 1920.

British Department of Scientific and Industrial Research: Third Report on Colloid Chemistry, and its General and Industrial Applications. 1920.

British Department of Scientific and Industrial Research: Report of Inquiry Committee on the Standardization of the Elements of Optical Instruments.

British Food Investigation Board: Report for 1919.

Critical Revision of the Genus Eucalyptus, by J. H. Maiden, vol. 5, part 3.



SCIENCE AND INDUSTRY.

VOL. 2.] DECEMBER, 1920. [No. 12

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Suspension of Publication of the Journal.

WE have to announce that it has been decided by the Executive Committee to suspend publication of *Science and Industry* after the issue of this number. This decision was arrived at only after full and careful consideration of the circumstances in which the Institute is placed, and it was felt that the stage has now been reached when it were better to call a halt rather than to struggle along without a strong and definite purpose. The first objective has been gained, and the position won has been consolidated. A temporary organization has been placed upon a permanent basis, and an Institute of Science and Industry has been established for Australia. Having assisted to accomplish this much, there is now no other course open than to await developments, and to leave it to the Director, whose appointment, presumably, will be made in the near future, to determine exactly the nature of any regular official publication, and to formulate a clear-cut policy which the stabilized position brought about by the passage of the Science and Industry Bill will now permit.

The task of publishing each month a journal designed to stimulate interest in the achievements of science, and its application to industry, must, under the most favorable circumstances, be a difficult one. In our case it would have been an impossible one had it not been for the

splendid support accorded our efforts by the many talented and unselfish workers in the various branches of science. It is desired to thank these contributors for the assistance they have rendered.

When it was first decided to publish a monthly journal it was thought that the Institute almost immediately was to be given statutory authority and richly endowed with funds. Had these prospects been fulfilled a regular official publication detailing the activities of the Institute would have been necessary. Pressure of legislative business, however, delayed the introduction of the Bill for so long a period that during the currency of the journal no additional work of any great importance was undertaken. The activities of the Executive Committee were confined largely to the continuance of the investigations previously entered upon, and to discharging certain advisory functions on behalf of the Government. The necessity for a regular publication, therefore, for the time being disappears. Future action will depend upon the expansion of work undertaken by the Institute.

If for no other reason than to show the value of an organization, adequately financed and equipped, such as that which has now been created, *Science and Industry* has fully justified itself. Not having been in the position up to the present of embarking upon a comprehensive and definite scheme of work, reference had to be made largely to the activities of kindred organizations in other parts of the world. Similar successes to those which these institutions have so quickly won may be confidently looked for in Australia when similar financial backing is forthcoming. However, several important investigations have been put in train, and they are yielding the most encouraging results. Pending the appointment of a director, and the preparation of his plans for a permanent policy, the interim reports of these various committees of inquiry will be communicated to the daily and technical press of Australia, and, when necessary, special statements will be prepared and circulated among persons particularly interested in the work in hand.

EDITORIAL

INSECTICIDE INVESTIGATIONS.

A further report on the insecticide investigations being undertaken at the Oregon Agricultural Experiment Station presents one or two valuable conclusions. In an abstract of the work published in *The Review of Applied Entomology,* it is stated that the investigations show that acid lead arsenate is more effective than the basic salt, the proportion assimilated by the larvæ being greater. One pound of the acid lead arsenate in 400 U.S. gallons of water was effective against very small tent caterpillars (Malacosoma), and would probably be equally so against newly-hatched codlin moth larvæ (Cydia pomonella). The ordinary commercial lead arsenates are nearly pure acid lead arsenate. The powdered form is superior to the paste and keeps better. Substances known as spreaders, which increase the covering power and adhesiveness of the spray, add greatly to its efficiency. The most practical in order of merit are: caseinate, glue, soap bark, and oil emulsion. They are not improved by the addition of phosphates or sulphates. The three factors, method of application, the spray solution, and the spray material, all affect the efficiency of the spray, and the improvement of any one of them decreases the relative importance of defects in the other two. In the calyx application for codlin moth a fine, misty spray is as effective as a driving spray. But undue importance should not be attached to the calyx spray. In Oregon usually less than half of the infestation is due to the calyx entry; it is the last brood of larvæ which infests the fruit late in August and early September that causes the heavy losses and is hardest to control, owing to the difficulty in timing the spray. The calcium arsenates have a high killing efficiency, but are not so staple as the lead salts, and an excess of lime is advisable in solutions of them. There is probably no adequate reason for the abandonment of lead in favour of calcium arsenate for orchard work. Nicotine sulphate is a powerful repellent for tent caterpillars, and if feeding does take place, even weak solutions kill almost instantly. It is an effective ovicide for codlin moth, especially with the addition of soap, but is not to be recommended as a substitute for the standard arsenate sprays in codlin moth control; though it may prove highly efficient as a substitute for the arsenate spray in the July application where a serious summer reinfestation of aphides is present or again in combination with the last summer application of arsenate with a spreader, as a further insurance against the damage caused by the last brood of larvæ.

DUSTING *VERSUS* SPRAYING.

The conclusions arrived at by the Virginia Agricultural Experiments Station regarding the relative efficiency of dusting as compared with spraying are that neither in the case of apples nor peaches can dusting be regarded as giving a satisfactory general control. Recent experiments demonstrated that dusting, as compared with spraying, saves time and labour, especially where rough ground hampers the use of the heavier liquid outfits, but it has several limitations in practice in the case of both peaches and apples. The following formulæ were used in dusting experiments (the parts being by weight) :—For peaches, sulphur and lead arsenate 90-10, and sulphur, filler and lead arsenate 50-40-10; for apples, a Bordeaux dusting mixture and an 80-10-10 mixture of sulphur, filler and lead arsenate. In peach orchards both the dusting mixtures produced a satisfactory control of scab (Cladosporium carpophilum), and probably curculio (Conotrachelus nenuphar), but were of only slight value in the control of brown rot (Sclerotinia cinerea); consequently though they may be used for the first two summer applications, they cannot be relied on for the third or subsequent ones. In apple orchards both mixtures produced a satisfactory control of the codlin moth (Cydia pomonella), and the Bordeaux dust gave excellent results against blotch (Phyllosticta solitaria) and frog-eye (Sphaeropsis malorum); but they were little better than no treatment at all against bitter rot (Glomerella cingulata). As a result it would seem that neither in the case of apples nor peaches can dusting be regarded as giving a satisfactory general control; and as its use must therefore necessitate duplications of equipment, the best results will probably come from the methods and materials the value of which has already been proved.

A SUBSTITUTE FOR NICOTINE.

A decoction of the stems and leaves of the tomato plant, especially if prepared with the household washing lye made with wood ash, is a very potent insecticide that may be diluted with water and used for spraying in the same way as nicotine. The active principle in the tomato stem is more injurious than that in tobacco leaf. The leaves of Digitalis grandiflora yield digitalin, which is as powerful as nicotine and serves admirably against the beet aphis (Aphis rumicis), the hop aphis (Phorodon humuli), fruit tree Aphids (Haltica ampelophaga, &c.) It is in June and July, when the plant is in flower, that the leaves are richest in alkaloid. To prepare the decoction, 30 lbs. of stems, with the leaves, are boiled for 30 minutes in 20 gallons of water. The solution must be stored in labelled containers, as it is a violent poison, and it is diluted for use with an equal part of water. It is less liable to scorch than nicotine. Petroleum, at the rate of 1 part by weight per 100 parts of spray solution, is another substitute for nicotine. The following is a tested formula :—Petroleum, 5 lbs.; panama bark, 1 lb.; water, 3 gallons. The bark is crushed and boiled in the water until about 2½ gallons of liquid is obtained; this is strained through a fine cloth and the petroleum is added by degrees with constant beating until a perfect emulsion results. This is diluted with 50 gallons of water.—*Journal d'Agriculture, Pratique*, Vol. XXXIV., No. 27.)

NEW INDUSTRY.

It is interesting to know that, as a direct result of the researches carried out by the Institute of Science and Industry on the utilization of Zamia palms, a company has erected a factory on the south coast of New South Wales, and is commencing operations for the conversion of raw starch from the Zamia palm with the promise of an important and successful industry being established. The New South Wales Forestry Commissioner has granted a licence to the Austral Starch Company to obtain Zamia bulbs from an area of about 31,000 acres in the vicinity of Currawan. The licence has a period of ten years, and is subject to the satisfactory observation of conditions, and include the erection of a local factory or factories within six months, and the manufacture of not less than 50 tons of dry starch half-yearly. Particulars of the investigations carried out by the Institute were published in *Science and Industry,* Vol. 1, No. 8, December, 1919, pages 470 to 475.

LESPEDEZA AS A FORAGE CROP.

Lespedeza, as a forage crop, is a subject of a bulletin recently issued by the United States of America Department of Agriculture. Its scientific name is Lespedeza striata, and it is commonly known by the name Japan Clover. It is recommended as one of the most valuable forage plants for the south-eastern part of the United States. Except on alluvial bottom lands, it does not make sufficient growth to justify its being cut for hay; nevertheless, its widespread adaptation to grazing conditions gives it a value that is difficult to estimate. It will grow in open woodlands, on the poorest of upland hills, along roadsides, and in other waste places. Although an annual plant, it produces sufficient seed even under close grazing to re-seed itself, and is, therefore, as useful as if it were a perennial. Being a legume, it is valuable for soil improvement, and also it is relished by all classes of live stock. On the southern markets lespedeza hay has been well and favorably known for several years. The growing of lespedeza should be encouraged in all the pastures of the south, especially in the cut-over pinelands of the coastal plain. It may also be utilized to advantage as a hay crop on the rich-bottom lands of the Gulf States. It is slow in starting in the spring, but makes its best growth during the hottest part of the summer, when grass plants are likely to be dormant.

PROPOSED GERMAN CHEMICO-TECHNICAL LABORATORY.

A memorial has been presented to the German National Assembly urging the formation of an Imperial Chemico-technical Laboratory, which it is recommended should be formed from the Military Test Bureau which existed during the war. "Nature," quoting from the *Zeits des Vereines deuscher Ingenieure*, says that it is suggested that the functions of the new laboratory should be, *inter alia,* the execution of scientific and technical investigations relative to raw materials, and particularly (1) the production of materials of importance to the public, *e.g.,* spirit from wood and acetylene instead of from potatoes, and of fatty acids from the products of coal—or lignite-tar or paraffin—

and the utilization and improvement, not only of cellulose as a substitute for cotton, but also of ammonium nitrate obtained synthetically in large quantities as a fertilizer; and (2) the determination of substitutes for chemical and metallurgical products not available in the country, or of which there is a shortage, *i.e.*, substitutes for paraffin, camphor, and glycerine, for substances used in the preservation of leather and metals; also substitutes for lubricants, rubber, gutta-percha, &c. In addition, the proposed new institute would carry out researches of general interest, *e.g.*, on rust-prevention and the corrosion of metals, on the determination of stresses in internal-combustion engines, on the effect of winter cold and the upper-air temperatures on implements and raw materials, and on the testing and improvement of aeroplane and airship fabrics. It is also suggested that scientific and technical investigations should be carried out dealing with the prevention of accidents and the protection of workers in a number of important industries.

NELA RESEARCH LABORATORIES.

The Journal of the Franklin Institute, September, 1920, announces extensive additions to the Nela Research Laboratories. The Nela Research Laboratory was organized in 1908, under the directorship of Dr. Edward P. Hyde, as the Physical Laboratory of the National Electric Lamp Association. The name was changed to Nela Research Laboratory in 1913, when the National Electric Lamp Association became the National Lamp Works of General Electric Company. For some years the laboratory was devoted exclusively to the development of those sciences on which the art of lighting has its foundation, but in 1914 the functions of the laboratory were extended by the addition of a small section of applied science, which had an immediate practical objective. The section of applied science is now being largely extended as a separate laboratory of applied science under the immediate direction of Mr. M. Luckiesh, who becomes director of applied science, and a new building is being constructed to house this branch of the work, which will be carried forward with a staff of several physicists, an engineer, an architect, and a designer, together with the necessary technical and clerical assistants. Dr. Ernest Fox Nichols, formerly president of Dartmouth College, and more recently Professor of Physics at Yale University, has accepted an invitation to assume the immediate direction of the laboratory of pure science, under the title of director of pure science. The work of this laboratory, which will be continued in the present building, will be somewhat further extended under the new organization. The laboratory of pure science and the laboratory of applied science will together constitute the Nela research laboratories, and will be co-ordinated under the general direction of Dr. Hyde, who becomes director of research.

PHYSICAL RESEARCH IN CALIFORNIA.

The Californian Institute of Technology received from Mr. Norman Bridge an additional gift of £20,000 for the Norman Bridge Physical Laboratory. His original gift for this purpose was £30,000. The construction of the building is to be commenced immediately, and it is anticipated that the laboratory will be completed at an early date.

INHERITANCE OF CERTAIN CHARACTERS WITH CASTOR OIL PLANT.

The castor oil plant, botanically known all the world over as Ricinus communis, presents many forms which have from time to time been considered as distinct species. Many of these forms transmit their characters integrally to their descendants. This has been shown by control cultural experiments made at the Brooklyn Botanical Gardens with numerous pure strains of the first, second, and third generations. Series of crosses were made between the most widely divergent forms, and these gave in every case perfectly fertile and normal F, and F_2 hybrids. Crosses were made to study the inheritance of many distinct characters, *e.g.*, stem colour, presence or absence of pruina, dehiscence and indehiscence of capsules, colour of spermodern, shape and size of the seed, periodicity, length of stem, growth, shape of leaves, &c. These have been proved to be mendelian characters, but the experiments made so far do not warrant conclusions being drawn as to their gametic structure. The results already obtained will be of great value to those carrying out similar work, especially in Queensland, where the Institute of Science and Industry, in co-operation with the Queensland Acclimatization Society, has similar work in progress, and in Western Australia, where certain testing work is about to be commenced. The relative dehiscence of the capsules is a most important characteristic. In the dehiscent type, the ripe capsules open spontaneously with violence, scattering the seeds around to a great distance. This is probably caused by cells which, when ripe, rapidly lose their moisture and contract, causing the pod to break and expel the seeds. This is a very unfavorable character, and necessitates frequent harvesting—at least twice a week—to avoid the loss of large quantities of seed. The walls of dehiscent capsules are very thick and tough. In the indehiscent type the seed adheres to the walls of the fruit when it is completely ripe. When the cross is made between dehiscent x indehiscent form, dehiscent plants, and in the F_2, both dehiscent and indehiscent forms in the ratio of 9.7. Dehiscence, it would appear, is due to two factors, with the full determination of the various mendelian characteristics.

THE USES OF CASTOR OIL.

The largely increasing uses which industry is finding for castor oil were indicated in a recent number of the *Engineering World*. Castor oil figures to a large extent in the manufacture of the artificial leather which takes the place of natural leather in upholstery. It is also an essential component in some artificial rubbers and various kinds of celluloid. The oil furnishes a colouring for butter, and from it is produced the so-called "Turkey-red" oil, which is an important factor in the dyeing of cotton textiles. One of the largest uses of castor oil is in the making of transparent soaps. The oil also yields sebacic acid, which is employed in the manufacture of candles, and from it is also obtained caprylic acid, which enters into the composition of varnishes peculiarly suitable for the polishing of all kinds of high-class furniture and of carriage bodies. Castor oil is also used in the making of certain waterproof preparations. Most fly-papers owe a large part of their instantaneous action and effectiveness to the fact that the preparation smeared on them largely consists of castor oil.

FREEZING OF BEEF.

The report of the last year's investigation of the Food Investigation Board, which was appointed by the Department of Scientific and Industrial Research, contains a great deal of matter of close interest to Australia. Several committees have been appointed, and between them they cover a wide field of work. The committee have already carried out valuable preliminary experiments on the freezing of beef. It is a remarkable fact, familiar to the industry, that, whereas mutton can be frozen without damage, beef cannot. The effect on freezing of the latter is to so alter the muscle substance as to cause the meat, on thawing, to exude a fluid rich in nutritive material and coloured with hæmoglobin; and new experiments prove that, provided certain precautions are taken, beef can be frozen in such a way as to preserve completely the physical and chemical qualities of the fresh meat. The experiments were carried out with small pieces of beef, and an attempt to repeat them on a commercial scale has, so far, failed for want of adequate apparatus. Further investigations therefore had to be postponed until a low temperature research station is provided. The Board has supplied, however, a grant of money sufficient to build such a station, fully equipped for biophysical and biochemical investigations at low temperature. The University of Cambridge have presented a site for the erection of the station in close proximity to the Biochemical Animal Nutrition and Botany.

MANUFACTURE OF OXYGEN.

Research work on the manufacture of oxygen from the engineer's point of view has been initiated at the Harvard University Engineering School. The United States of America National Research Corporation has granted £1,000 towards the expense of the work. A scheme of work is being undertaken to determine the fundamental data. It is believed that present methods of making oxygen are wasteful, and that the industrial use of oxygen furnaces may result in the elimination of this waste. The Engineering School has agreed to turn over to the Research Corporation any patents they may develop from this work.

REFRIGERATION PROBLEMS.

At the first annual conference of the Victorian Institute of Refrigeration, held in Melbourne recently, the following papers were read:— Refrigeration as applied to Meat Works, by Mr. R. C. Pidgeon; Refrigeration as applied to Bacon Factories, by Mr. B. C. Jones; The Treatment of Small Goods and By-products, by Mr. S. M. Letts; and Refrigeration as applied to By-products in the Meat Works, by Mr. F. J. White.

A Note on two War Achievements of Applied Chemistry and their Significance for Australia.

By A. E. LEIGHTON, F.I.C., Member of Council, Chairman,
Board of Administration, Government Factories.

The sufferings of the British Forces early in the war due to shortage of ammunition cannot be forgotten; the strenuous effort that was made to put matters right and the eventual triumphant success are widely known. In this success the chemist played a substantial part, for it was his knowledge and resource that led to the great production of the two most important constituents of ammunition—cordite, which propels the shell from the gun, and the high explosives, or T.N.T., which bursts the shell. These two substances are the forms of potential energy which make the shell—itself a piece of dead iron—into a moving and rending force.

When the war broke out in 1914 the total capacity of the British cordite factories did not greatly exceed 100 tons per week, though not so much was actually made. At the end of the war their capacity had reached something over 2,000 tons per week. As for high explosives required to fill the shell, it is doubtful whether the whole of the plants in Britain at the opening of the war could have produced more than 10 tons per week, whilst the amount actually made was very small. At the end of the war British factories could produce more than 1,500 tons of T.N.T. per week. To a very large extent the increased capacity for making these two forms of explosive was locked up in two factories —Gretna and Queensferry. These two factories were in many ways extraordinary. They were entirely war creations, and were not mere extensions of already existing works. Their design, of course, followed conventional lines, and it may be of interest to learn that these plants required each week:—

2,300 tons of sulphuric acid.
2,000 tons of nitrate of soda.
2,000 tons of oils and fats.
360 tons of cotton.
600 tons of alcohol.
300 tons of toluene.

There is romance in these figures if one pictures the sulphur and sulphides coming from Norway, Spain, and Mexico, nitrate from Chili, rum from the Indies, cotton from America, Egypt, India, and oils and fats from all over the world. That list of supplies will suggest the intimate relation between industrial organization and preparedness for war. The supremacy of Germany in the line of organic

chemical manufacture made many difficulties for England, and the story of toluene supply for T.N.T. manufacture is specially to the point.

At the outset of the war our toluene supply was small, and came from the few gas-works and coke ovens which were fitted with recovery and refining plants. At a later stage the greater part of the toluene used was derived from a channel that before the war had fed the German industries. For many years there had been at Rotterdam a distillation plant for extracting toluene from Dutch East Indies petroleum, and quite early in the war the British Government acquired that plant, moved it to England, diverted the petroleum, and for some time mainly depended on this source for toluene. Welcome as was this supply, it was all too small to meet the increasing demands of war, and, at a later stage, the situation was only met by the extension of recovery methods to virtually all the gasworks and coke ovens in Britain. We were then, in this respect, in the position that Germany held at the opening of the war.

In July, 1915, the sites of the two factories were undisturbed fields. In December, 1916, within eighteen months of the start, the Gretna factory had produced 5,000 tons of cordite, and the Queensferry factory had made somewhat similar progress, though its full development had to await the supply of toluene. To the armies in the field, the eighteen months must have been a weary wait, but, viewed from another aspect, those eighteen months have significance. In that short time the industrial community of Britain transformed supplies, labour, and knowledge into war material, and to such purpose as must have surprised the Germans, who were by no means sluggards. We can be quite certain that the lesson has not passed unheeded by other industrial communities. What man has done, man can do, and when such nations as America, Britain, and Japan talk about disarmament, it only means that it suits them at the moment to stop locking up money and effort in the non-productive shape of warships and guns. It does not mean that they are disarmed, for an industrially developed nation cannot be disarmed. Exact knowledge of munition production, a nucleus of skilled workers, supplies, and then within a few months a nation is transformed. So much we can learn from the story of Gretna and Queensferry. Nor does such change involve immense *personnel*, for, in looking back at the history of most of the great war factories of England, one sees a leaven of research and exact knowledge, an army of unskilled workers—mostly women—not so numerous, but filled with patriotism and a passionate devotion to their men in France. Those qualities are not peculiar to the men and women of Britain, and are psychological factors that must be taken into account when calculating what other nations could do.

Disarmament, in its obvious sense, will not necessarily turn Britain into a mere shopkeeper with his teeth drawn; the power to retain a strong position in the world depends ultimately, not on the possession at any moment of the ships, engines, and munitions of war, but on the extent and variety of the nation's industries and the possession of knowledge to apply the resources of the industries quickly and effectively to the problems of war. Danger lies in the fact that other

nations are shopkeepers too; some of them shrewd, industrious, and eager to strengthen their position in every respect, whether it be the training of labour, the supply of materials, or the application of sound methods in manufacture and training. What is Britain's attitude towards such questions?

I do not think that at any previous period was there such a flood of industrial research and investigation as is passing over Britain at this time, and if she fails to keep the first place it will not be for want of awakening of spirit. The war brought research to every door, for restricted supplies of raw material and labour left no room for complacent people who were using ten things where seven would do. The improvement in efficiencies brought about by the close control of labour and material, backed up by scientific advice as to the best way to use them, was most extraordinary, and there is no doubt that the house to house visiting by research has left its impress. This is one great gain from the war, and it promises a permanence to industries that are vital to Britain's safety, for the result of peace-time struggles for industry largely determines the course of war.

I cannot pass from this subject without a reference to the splendid services rendered by the Officials Research and Inspection Establishments. Many persons are dimly conscious of what was done by the National Physical Laboratory and the Inspection Department for the mechanical arts; but few know of the work done for the chemical industries by Robertson and his men of the Research Department at Woolwich. The Research Department grew out of the Boer War; it was designed to improve the quality of munitions and to be informed of modern progress—both these things it did very well—and though the war was marked by constant change in the composition of munitions, new design of either factories or war material were boldly faced because they could be built on a basis of trustworthy research.

I remember talking this matter over with an officer who had served at the War Office with Lord Kitchener during 1915, the agony of preparation, and he said, "Those research men are the greatest fellows in England," and added, "God bless 'em," and with that opinion I believe the average British manufacturer most cordially agrees.

I have digressed somewhat from Gretna and other war factories, but, after all, these are of the past, and interest lies in their value as a guide to what has to be done here before Australia should enjoy any feeling of security. In the first place Australia is not in the fortunate position of those countries that can afford to contemplate "disarmament," for she is not yet a manufacturing country, and her provision against attack must take the positive and costly form of adequate stocks of finished munitions. Until the industries of the country are in a position to maintain a flow of munitions commensurate with the defence requirements, we must adhere to this policy of importing and holding stocks, despite its cost and attendant dangers. The last few years have been marked by great advances in manufacture, and it is not to be denied that most things can be made here. It is not likely that a people derived from the greatest industrial nation in the world should not be able to make anything it is willing to pay for; but there is a world of difference between ability to make things and a capacity to manufacture

them in mass. The latter argues the possession of a large stock of tools and a stock of trained brains and hands that can be readily switched to any direction that the political situation may demand.

In respect of supplies of natural material I should suppose that Australia is better placed than most countries, but, of course, natural material has to pass through many phases before it reaches the stage of being a "supply" for the machines or apparatus that produce finished munitions. It is no doubt pleasing to know that Australia has illimitable quantities of iron ore, but what the munition maker wants is steel of certain quality, rolled to a certain shape. There is no nation that has more salt at its doors than Australia, but the munition-maker wants caustic soda and chlorine. If this line of thought is followed in other directions you will discover our many deficiencies and how much remains to be done.

The tariff and recent legislation give evidence that the Government is prepared to encourage the industries of "supply," but, as will be readily understood, the evolution of a country from the stage of "illimitable resources" to that of a manufacturing community is a slow and costly process. That cost is borne by the people of Australia in the form of protective duties, and, in fairness to them, should be taken into account when making *per capita* comparison with defence expenditure in other countries.

There are two conditions that I consider should be attached to an Australian tariff. One is that protection should be "scientific," in the sense that Government when protecting an industry also protects the people of Australia from rule of thumb methods by insisting on an adequate measure of scientific control and guidance by managements. Such a step would give permanence to our industries and rapidly increase the national staff to chemists and engineers, without which the "illimitable resources" cannot be brought down to brass tacks.

The other condition is that protection should only be granted when the petitioning industry agrees to meet defence requirements. Two instances have come under my notice where industries enjoying protection at the expense of the people find it inconvenient to deliver goods in the shape or form required by defence or by other industries that strengthen our general position.

If these two conditions set out are complied with under the present tariff, it will go far towards solving the problem of "supplies."

The element of labour is a subject on which I can speak from considerable personal experience both in the chemical and the engineering industries. It is competent, readily adaptable, and will take up new forms of technology with enthusiasm. There is no fear that the worker will fail if the staff is clearly instructed as to what is wanted and "supply" is suitable; and it is in these directions that Government at the outbreak of war should be prepared to give guidance.

In peace the energies of industrialists must be free and occupied in the problems presented in maintaining and improving their position against world competition, but in war the burden of mass production of munitions could be assumed by them were the Government ready with the knowledge and equipment peculiar to their manufacture.

This, broadly, was the line of policy followed by the British—a nucleus of Government shops at Woolwich, Enfield, and Waltham for the development of methods of manufacture and instruction of masters and men, with laboratories for research on materials and products. Co-ordinating these was an organization which crystallized factory experience and laboratory knowledge into specification form, and through its inspection staff secured manufacture in accordance with its specifications.

The policy stood the severest of tests, and, in conjunction with a policy of scientific protection, is adaptable under Australian conditions. If steadily followed, it will enable our industrial resources to function in war and be a support to the fighting forces on which the existence of our nation finally depends.

Arrangements are now being made for the experimental production of power alcohol on a considerable scale in India. Rice straw is to be used in the first place, but other cheap raw materials are available, and it is believed that within two or three years large supplies will be available to be imported into the United Kingdom.

Among the new industries established in South Africa during the year 1919 were aluminium works, ammonia, asbestos cement, bone char, briquettes or patent fuel, cream of tartar, dextrine, lacquer, and gold size.

Combined Sprays for Controlling Insect Pests and Fungous Diseases.

By EWEN MACKINNON, B.A., B.Sc.

Plants, like man and other animals, on account of their living cellular structure, are liable to disturbances of the normal functions of the cells. The cause of these disturbances or diseases may be due to physical, chemical, or parasitic elements. *Physical* causes depend largely on climate and seasons. Heat, cold, drought, excessive moisture in the air or soil, excessive or diminished sunlight, are factors which greatly influence plant growth. When one or more of these factors act unfavorably, the vitality and resistance of the plant is generally lowered and becomes a predisposing cause of attack. Many fungi are only able to attack plants that are in an unhealthy condition, and many are known as wound fungi and others as facultative parasite, *e.g.*, the fungus *Alternaria solani* (E. & M.) is most generally stated to be the cause of "black spot" on the tomato. It is only secondary, however, and attacks this fruit commonly towards the flower end, owing to the weakening of the tissues there through excessive or diminished supply of water to the roots. In experimental infection experiments it has been found that uninjured healthy tissues do not become infected. Weather conditions have a very important influence on the prevalence of disease. The brown rot (*Sclerotinia fructigena*) of stone fruits has often been most destructive during warm moist springs and almost absent during similar dry periods. The year 1914-15 was a good example, when destruction was very heavy in New South Wales, where rainfall was 7.8 inches above normal for the spring and summer (August-January), whereas the previous year 1913-14 had a dry summer, 13.4 inches below normal, and very little brown rot. Late (or Irish) blight of potatoes (*Phytophthora infestans*), which is entirely dependent on a sufficient supply of moisture for its rapid development, may be thoroughly checked by a hot, drying wind, such as a westerly in New South Wales in the summer. Temperature is of less importance than moisture in the case of blight, as the conidia will readily germinate between the temperatures of 50 deg. and 77 deg. F., while the mycelium will continue to grow until the temperature reaches 88 deg. F., provided the moisture is sufficient in all cases.

As regards the effects of weather on insect attack, it is a fact very often observed by growers, that aphid attacks frequently coincide with moist air conditions, whereas red spiders and most species of thrips are more abundant, and hence more injurious during warm, dry conditions. The codling moth is a good example of a well-known destructive insect whose development is greatly influenced by weather conditions. The rate of its development, the time of emergence of broods, the number of broods, &c., are influenced by latitude, early and late, cool and warm, and wet and dry seasons. As in the case of potato

blight and other fungi; there appears to be a degree of atmospheric humidity, which is most favorable to the maximum speed of insect metabolism, and this optimum humidity varies for each species, and for each stage of each species.

The *Chemical* factors producing disease relate especially to the composition of the soil from which the plant draws many of its requirements for life, and growth and reproduction. Poisonous gases in the air, however, frequently cause great destruction of plant life. This is well shown in the neighbourhood of large smelting works, of which there are many examples within the Commonwealth—notably the sulphide works at Cockle Creek, New South Wales. The use of certain chemicals in the soil has often an important influence on the susceptibility of plants to disease, and the effects of traces of many substances, such as "Manganese and Fluorides," have been investigated. It is generally well known to orchardists and others that a fertilizer like sodium nitrate will often promote a leafy growth, but that susceptibility to disease may be increased. Sulphur has been commonly used both as a disinfectant and a fungicide, as in potato scab. Thus the selection of the right kind of manure is of great importance in attempts to combat diseases.

Parasitic factors.—Although it may appear that there are many points of resemblance in the methods of attack by insects and fungi, closer investigation has revealed many important differences, of which an accurate knowledge is essential before we can hope to devise any successful methods of control. There is usually some period or stage in the existence of parasites (insect or plant) when they are most susceptible to attack, and we must study their whole life history and take advantage of the information thus gained. This becomes the more obvious when it is found that, during a considerable part of the life of most insects and fungi, these are either very resistant to any destructive agents, or they are inaccessible, being securely buried in the tissues, or hidden away, or in some manner protected from attack. We have further to remember when devising remedies against the parasites attacking plants, that the latter also consist of living cells somewhat similar to those of the parasites which we hope to destroy. It follows from this that two of the factors that determine the effectiveness of the remedial substance are—(1) that it must be capable of destroying the fungus or the insect when it comes in contact with it, and (2) it must not be injurious to the tissues of the host plant. These requirements restrict the choice of such fungicides and insecticides, and a further limitation arises in the selection of certain spraying and dusting materials when other factors which determine the efficiency of this method are also taken into account. These factors are—(3) that the "spray" must adhere after its application so that it is not removed by the first light rain that occurs, and (4) that the "spray" must retain its effectiveness after drying on the plant. These latter apply more particularly to preventive sprays against fungi and poisonous sprays against biting insects. In fruit-growing, spraying is now regarded as essential to the production of clean, healthy fruit and good crops. It is an insurance which it is not wise to neglect. A control seemingly unprofitable from the money stand-point for one particular year may

be profitable from the stand-point of the health of the trees and of future production of fruit. Orchardists recognise what is known as the cumulative effect of continuous spraying. This is very evident in the rejuvenating of neglected orchards. The first year's pruning and spraying may not show very much reduction of disease, because there are too many sources of infection to be exterminated or controlled in one season. With the continuation of the second and third year the results of the cumulative treatment will be obvious. The Black Spot disease (*Phoma citricarpa*) of oranges, and the Brown spot disease (*Colletotrichum glœosporioides*) of the Mandarin show striking examples of this cumulative result. We have to beware, however, of an opposite injurious effect, also cumulative, on the vitality of the tree, if the treatment after two or three years be not reduced to the minimum consistent with efficient disease control. Excessive spraying may inflict a serious check on the vigorous growth of the tree.

For many legitimate reasons, therefore, the practice of reducing the number of sprayings or other similar treatments to as few as possible, while increasing the number of ingredients in the spray so as to counteract both fungi and insects in the one operation, has greatly increased, and many growers have adopted certain mixtures with success. There are many pitfalls, however, as some of the most widely used spraying materials are complex chemical substances, varying in composition according to the method of manufacture, purity of materials used, and the ideas of various manufacturers of the commercial products. Some substances are insecticides only, or their fungicidal properties are of little value, *e.g.*, oil emulsions and lead arsenate; others are fungicides only, *e.g.*, Bordeaux; while others act as both insecticide and fungicide, *e.g.*, limesulphur solution. Although many of these substances can be mixed and used as combined sprays, indiscriminate mixing will result in disaster—injury to the trees, loss of time, materials and crop, and possibly loss of faith in such remedies. The mixing of such complex substances demands a good chemical knowledge, and when the grower is in doubt as to the results of mixing two or more insecticides or fungicides, the best advice that can be given is "Do not mix them." The following reasons may be given in favour of not adopting the practice of mixing up "one specific to be given in one dose, to exterminate all pests":—

(1) Each type of remedy generally requires application to the plant in a special manner, and in particular with a varying adjustment of the spraying nozzle, *e.g.*, nicotine, a coarse, driving spray; lead arsenate or Bordeaux, a fine, misty spray.

(2) Each pest has its own particular period when it is most susceptible to attack. The best success will be obtained by using the most efficient remedy at the most advantageous time.

(3) Many of the substances used for spraying, when mixed, react chemically with one another, whereby the efficiency of one or both may be reduced, or new products are formed, which may act injuriously on the leaves or fruit.

The reasons for combining insecticides and fungicides, however, may be sufficiently urgent as to justify the action, *e.g.*:—

(1) Although plants are often attacked independently by fungi, bacteria, or insects, these may, and often do, work in combination. (See Sc. and Ind., Nov., 1920, p. 652, on the "Role of Insects in the Dissemination of Diseases.") In such cases a combined spray may be of decided value.

(2) In places where there is a great shortage of labour and also where spraying materials are expensive, a combined spray would be preferred.

(3) Under various state laws relating to spraying for the control of orchard pests and diseases, *e.g.*, for codling moth and fruit fly, &c., the grower is compelled to carry out a certain minimum number of sprayings with specified substances (mostly arsenate of lead of an approved brand). He may, therefore, combine other substances with that required by law in order to reduce to a minimum the number of sprayings that he would find it necessary to give in order to keep all pests under control.

(4) In response to demand, scientists have investigated the results of combining two or three spraying materials, and many experimental spraying or dusting tests have been conducted in orchards and elsewhere under appropriate control. Consequently, the grower can now obtain advice on what to mix and what not to mix, the precautions that he must exercise, and the results that he can expect, from the use of his mixture.

In combination sprays, each substance should be selected for definite reasons, *e.g.*, in spraying peach trees one application of Bordeaux at the correct time is sufficient to prevent practically all damage from peach leaf curl (*Exoascus deformans*). At the same time arsenate of lead may be added for peach tip moth. The same mixture is very efficient as the first spray (pink bud stage) for apple diseases and insects. The lead arsenate also complies with the requirements of the law. In all cases when selecting insecticides it is necessary to distinguish between biting insects and sucking insects. The former (*e.g.*, beetles, grasshoppers, caterpillars, wireworms, and cut worms) have their mouth parts developed for biting and chewing plant tissues; the latter (*e.g.*, aphids and other plant lice, mites, and bugs) have their mouth parts developed as a sucking tube which enables them to pierce the outer coatings of the plant cells and to suck the juices from the internal tissues. Biting and chewing insects can be killed by means of poisons placed on the surface of the plant. When the insects feed on the leaves, the poison is eaten with the food, and acts through absorption in the stomach and intestinal tract. The sucking insects are killed by contact insecticides. These generally contain volatile substances, and death is mainly due to their absorption into the tissues of the insects. It was formerly thought that death was due to suffocation by the stopping of the breathing pores or the closing of the tracheæ. Recently, however, investigations indicate that insects are not so readily suffocated, and that the volatile parts of kerosene, nicotine, carbon disulphide, pyrethrum, &c., are effective long before the

liquids have time to penetrate the chitin or the spiracles into the tissues. The nervous system of the insect is affected by the penetration of the volatile substance, and results resembling narcosis are produced where there is a disturbance of the respiratory activity. The insect tissues soon become saturated when exposed to the vapours, and death ensues through the inability of the tissues to absorb oxygen in the presence of these vapours. (Mich. Ag. Col. Tech. Bulls. 11 and 21.) In the case of lime sulphur, its effectiveness is due to its reducing power, and with scale insects to its softening action on the wax about the margin of the scales, and to its effect on the waxen covering making it less permeable to oxygen. Carbon disulphide, hydrocyanic acid gas, sodium fluoride, &c., act strongly on the oxidases and other enzymes in the tissues of insects, causing serious changes. The non-volatile finely powdered solids, such as borax and sodium fluoride, as well as being stomach poisons, are effective contact poisons, adhering to exudations on the body, and later becoming dissolved are absorbed through the integument into the tissues.

Aphids, and other plant lice, bugs, and mites attack the under surface of the leaves, as this is probably easier to penetrate. By the sucking of the rich sap materials from the cells on the under side, the leaves curl somewhat, and so form a protective enclosure. Plant lice are so small that the grower often overlooks them and underestimates the damage that they cause. In attempting to control such pests with contact insecticides it will be understood that it is essential to spray the under sides of the leaves well, and a coarse, driving spray like nicotine can be used.

Although the list of insecticides and fungicides is very extensive, those in greatest demand for spraying may be summarized as follows:—

Fungicides.

1. Copper compounds (*e.g.*, Bordeaux and Burgundy) especially valuable as winter sprays and as preventive sprays in early spring.
2. Sulphur and its compounds.—Some are used with soap, such as ammonium polysulphide, potassium sulphide (liver of sulphur) and sodium sulphide. One which is both fungicidal and insecticidal—lime sulphur solution—is not used with soap.

Insecticides.

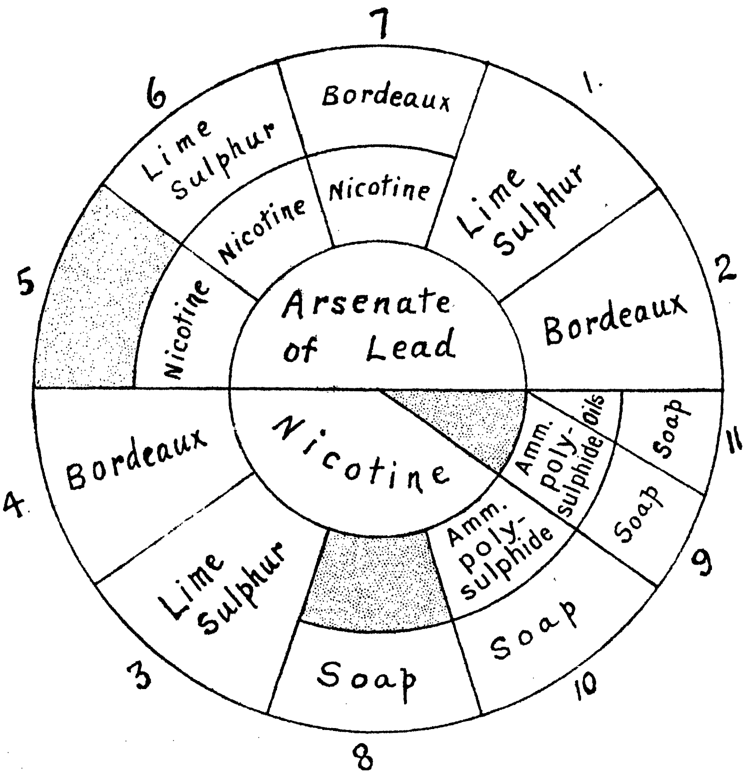
3. Arsenical compounds (*e.g.*, lead arsenates, Paris green) used as stomach poisons for biting and chewing insects.
4. Nicotine (or tobacco extract) used against sucking insects.
5. Oils and emulsions (kerosene, red oil, creosote, and distillate oils).
6. *Miscellaneous Methods* and gases, fumigants and repellents, which need not be mentioned here.

When we attempt to combine certain preparations we are immediately faced with the greatest difficulty that the grower is likely to meet, viz., the unknown nature of the many proprietary and commercial preparations on the market. He will have to learn how to make a few simple tests for himself, such as the test for the presence of free copper

compound in Bordeaux by using potassium ferrocyanide (the bright iron blade is not reliable and the other test is simple); the test for arsenate of soda in lead arsenate, by using lead acetate solution; and how to test for acids and alkalies.

He should also demand from the supplier full information about the preparations, such as the percentage of nicotine in a tobacco extract; the nature of the lead arsenate, whether neutral or acid; the absence of free arsenic or arsenate of soda in lead arsenates; the percentage of polysulphides in lime sulphur solution, &c.

In order to assist the man on the land the accompanying chart has been prepared, and will show at a glance what preparations can be mixed.



In the central circle I have placed the two insecticides, arsenate of lead for biting insects, and nicotine for sucking insects. The chart should be read in any direction radiating out from the centre, and those preparations adjacent in a radial position can be combined without one or other of the constituents being altered to any great extent, or their efficiency reduced.

In all cases it is advisable to use combined sprays as soon as they are prepared. The following combinations occur:—

(1)	Arsenate of Lead	+	Lime Sulphur Solution.
(2)	„ „	+	Bordeaux.
(3)	Nicotine	+	Lime Sulphur.
(4)	„	+	Bordeaux.
(5)	Arsenate of Lead	+	Nicotine.
(6)	„ „	+	Nicotine + Lime Sulphur.
(7)	„ „	+	Nicotine + Bordeaux.
(8)	Soap	+	Nicotine.
(9)	„	+	Ammonium Poly-sulphide.
(10)	„	+	Am. Poly-sulphide + Nicotine.
(11)	Oils Emulsified with soap.		

(1) *Arsenate of Lead + Lime Sulphur.*

In the first case on the chart, combining arsenate of lead with lime sulphur will lead to trouble, if it be not restricted to the neutral type of lead arsenate. In America, good results have been obtained by mixing calcium arsenate instead of lead arsenate. Lime sulphür is easily decomposed, and is especially susceptible to change when mixed with other strays. Its own decomposition products are quite harmless, but its effects on its associates are frequently of a serious nature. If a lead arsenate of an acid character is used, soluble arsenic is likely to be found in the mixture, as arsenates are prone to yield soluble arsenic, especially in alkaline solution, but also in acid ones. Lime sulphur is an alkaline solution, and therefore all mixtures of lead acetates with lime sulphur are to be handled with suspicion. Soluble arsenic in the spray would soon ruin the trees.

Owing to the very great value and wide application of this combination, however, experiments have been made to ascertain how to correct the rapid changes that take place when these substances are mixed. In the United States of America it appears that 95 per cent. of the lead arsenate used is of the acid type, whereas in Australia, I believe, the neutral or tribasic lead arsenate finds most favour, probably because the brands that have given the best results happen to be of the neutral type. Mixtures of the neutral lead acetate and lime sulphur are fairly reliable. With the acid arsenate, changes of a more serious nature take place, and within two days of mixing all the polysulphides will be changed to lead sulphide, which is ineffective as an insecticide; but what is more objectionable, as much as 12 per cent. of soluble arsenic compounds may be found in solution. Such a mixture sprayed on trees would result in disaster. It has been found that if 10 lbs. of slaked lime be added to 100 gallons of diluted lime sulphur solution ready for spraying followed by the addition of the acid lead arsenate at the rate of 2 lbs. to the 100 gallons, the active polysulphides will be retained, and the arsenic will not be converted to

the soluble form. Such a combination is then safe to use immediately. The addition of lime to the neutral type should not be necessary, but it does no harm, and if the arsenic is not up to standard it may be the means of preventing injurious arsenic compounds going into solution.

These figures must be taken as a guide only, as the exact strength of the lime sulphur solution is not given and the lead arsenates vary so much.

(2) *Lead Arsenate + Bordeaux.*

This is a safe and useful mixture. On account of the excess of lime even acid lead arsenate or Paris green can be advantageously mixed with Bordeaux. In order to reduce the amount of copper sulphate, and to keep the lime in excess, the formula 5-5-50 has become very popular (5 lbs. of copper sulphate, 5 lbs. quicklime, and 50 gallons of water, instead of the old formula 6-4-50). It is a good combination for apple scab and caterpillars.

(3) *Nicotine + Lime Sulphur.*

Alkalies are unlikely to affect free nicotine in extracts. Nicotine sulphate, which is the principal compound of the alkaloid nicotine in the various spray substances, would be decomposed by alkalies, and the nicotine set free. It would be just as active in this form. The extracts on the market are very variable in composition, strength, &c. There is much confusion over the percentage of nicotine (alkaloid), or its salts, such as nicotine sulphate. We have local preparations, some of which give the percentage of nicotine and some do not. In all cases the grower should insist on being supplied with such information. This could readily be supplied if preparations that did not give full information were consistently rejected on that account. It is very handy to know that all one has to do is to boil a few ounces of soap with a gallon of water, add the nicotine, and make up to so many gallons. If the percentage of nicotine were known, the resulting spray could be compared with products and results elsewhere—*e.g.*, "Black Leaf 40," an American preparation, has been proved to contain the reputed 40 per cent. of nicotine sulphate. In some experiments similar results could only be obtained by certain growers using 1 part in 800 of water, 1 part in 500 water, and 1 part in 400 water. It was found that the soap, or soap powder, as used by some, was at fault. In many Australian preparations far too little soap is used. Nicotine is very much more effective when used with sufficient free soap. A well-known local extract contains 2 per cent. nicotine, and the 16-oz. tin (containing ⅓-oz. nicotine) is made up to 5 gallons of spray, using 4 ozs. yellow soap. This corresponds with a well-known English formula of 6 ozs. of nicotine (95 per cent. pure) to 100 gallons of water and 5 lbs. of soap. Another local preparation does not state the percentage of nicotine, and uses ounces, instead of pounds, of soap. Nicotine is a very effective and rapid killer of sucking insects, also of many biting insects that it may hit. A coarse, penetrating spray, with

high pressure behind it, is the best for this mixture, which will kill caterpillars and similar soft-bodied chewing insects. Unlike the arsenates, nicotine does not remain long on the leaves as a poison, as it rapidly evaporates.

(4) *Bordeaux and Nicotine.*

This may prove a suitable mixture if used at the right time. It is not generally recommended, chiefly because some tobacco extracts have a solvent action on the copper constituents, and spray injury would soon result from the use of liquids containing soluble copper compounds. The copper is also likely to precipitate the nicotine, but this may not matter.

(5) *Arsenate of Lead and Nicotine.*

This is a labour-saving combination, much used as an early spring wash against both biting and sucking insects, but it is not a fungicide. Each ingredient is more effective if used at its own time, nicotine being required often earlier in the spring. Further, the effect of nicotine is increased enormously when used with soft soap, and the strong, coarse spraying with nicotine is not the most suitable one with arsenate of lead, which requires it to be of the fine-mist type. As no fungicide is included, and as such would probably be essential, it would be more advantageous to separate these insecticides. Combine one with a fungicide, *e.g.*, the lead arsenate and Bordeaux, both of which require the same kind of spraying, and the other (nicotine) with lime sulphur alone, or with soap alone with which it is very effective.

(6) *Arsenate of Lead and Nicotine and Lime Sulphur.*

(7) *Arsenate of Lead and Nicotine and Bordeaux.*

These combinations can be used if required, although nicotine is much more effective with soap, but soap is not recommended with lime sulphur. The spraying with arsenate of lead or Bordeaux is also of a different character to that advisable for nicotine.

(8) *Nicotine and Soap.*

This is a most useful and effective spray. Many preparations are on the market, and, as mentioned under No. 3, the purchaser should select only those makes which supply full information as to nicotine content, amount or weight of substance, freedom from pyridine, and methods for use. Many growers prefer to prepare their own extract. A good method is to make an extract of 2 lbs. of tobacco stem or refuse in 2 gallons of water, boil up with $\frac{1}{4}$ lb. soap, and make up to 5 gallons. The strength of nicotine is not known. Nicotine may be used on the most delicate plants. The strengths of solutions used are varied for different varieties of insect, twice the strength being used for caterpillars as for aphids generally, also doubling the quantity of free soap, thus:—

4-5 ozs. (95 per cent. pure) nicotine, 2-4 lbs. soap for 100 gallons water, for bugs.

10-12 ozs. (95 per cent. pure) nicotine, 5-6 lbs. soap for 100 gallons water, for caterpillars.

(9) and (10) *Ammonium Polysulphide with Soap, with or without Nicotine.*

The preparation of effective spraying materials is an outstanding example of the success of the scientist. Bordeaux mixture was one of the earliest sprays developed in Europe for the control of grape diseases. Lime sulphur solution was the outcome of American work, especially for summer spraying on stone fruits. Now we have a valuable preparation as a result of work by Professor Salmon and Dr. Eyre, at Wye College, England, in their investigation on the control of the American Gooseberry Mildew now widespread throughout Europe. It has this advantage over lime sulphur—it does not leave any deposit on berries, &c., sprayed with it; hence it can be used at any stage without the fruit being marked. Powdery mildews have, as a rule, been treated with powder sulphur, and various mixtures of sulphur and other substances. American Gooseberry Mildew, however, in the powdery stage, is readily attacked by ammonium polysulphide solutions and soap, which is much superior to liver of sulphur (Pot. sulphide). Owing to the difficulty and danger in making ammonium polysulphide, it must be bought ready prepared in the concentrated form like lime sulphur solution, but smelling strongly of ammonia. It is an orange-red liquid, very pungent, but, when diluted, is harmless and non-poisonous. It should always be used with soap, and insecticides, such as nicotine, or quassia extract, can be added. Once prepared for spraying, it should be used and not allowed to stand for any length of time. Wooden and iron vessels are to be used, and the spraying machine well washed after use. It contains 18 per cent. of ammonia and 22 per cent. of combined sulphur, chiefly as the polysulphide 13 per cent., and the sulphide 9 per cent.

In a combined spray 1 gallon is diluted with 100 gallons of water, and there should be at least 4 lbs. of free soap present. The soap is boiled in the water required, and the ammonium polysulphide liquid is added and stirred well. When applied under proper conditions it not only stops the growth of the fungus and the spread of disease, but in many cases destroys the mycelium. The active ingredient is the ammonium polysulphide, and it is very useful against all kinds of mildew—rose, peach, apple, and gooseberry—and other fungi. It will be noticed that soap is not recommended with lead arsenate, lime sulphur, or Bordeaux. The difficulty of using soap with hard water and salt water is probably known to most people. The curd that floats to the surface is an insoluble hard soap, formed by the lime or salt in such waters decomposing the soap used and forming a new compound with part of it. Soap is a compound of the caustic soda (or lye) and the acid part of the fats used. With hard water the curd will continue to form, until all the substances in solution, causing the hardness, have been combined with the acid part of the soap, replacing the soda part. Any soap in excess of the quantity required to do this is known as free soap, and will be then available to make a lather, or to act as a film spreader. If soap were used with sprays containing lead, lime, or copper, each of these would produce an insoluble curd or

hard soap, thus converting the active parts of the spray into a curd and so reducing or destroying its value. The compositions of soaps themselves, of water available for mixing sprays, and the spray compounds, all vary so much in composition that many conflicting statements have been made as to the results obtained with various mixtures containing soap, lead arsenate, lime sulphur, &c. The grower should buy the best brand of which particulars are obtainable; should seek advice, and should learn to make certain tests for himself. The preparation of sprays should be carried out with some intelligence, and not left entirely to rule-of-thumb methods.

Oil Emulsions.

Many mineral oils are used as insecticides, practically always in the form of emulsions with soap, though a Woburn formula uses copper sulphate, limewater and kerosene, and no soap. The use of kerosene and soap as an insecticide, with good wetting powers when sprayed with considerable pressure, is well known. There should be plenty of free soap in the mixture, *e.g.*, for a summer spray—

> 100 gallons of wash contain 1 to 2 gallons kerosene and 10 lbs. of soft soap; other oils such as red oil "Miscible oils" and various "distillate oils" are used, especially for certain citrus scales, and for apple woolly aphis, &c.

When preparing emulsions it is essential to see that a proper emulsion is formed, and that it is vigorously agitated right to the end of the spraying, or to the emptying of the container. If the agitation ceases, and the emulsion has not been well made, there is a tendency for the oil to separate out, and as it floats to the surface the last spraying material in the container may be almost pure oil. This is dangerous to the trees, and has been the cause of frequent trouble with careless growers. Such oil sprayed on the trees has not only killed the bark, but has run down the trunks, and, being absorbed by the soil, has produced a rot, like a collar rot, round the trunk of the tree.

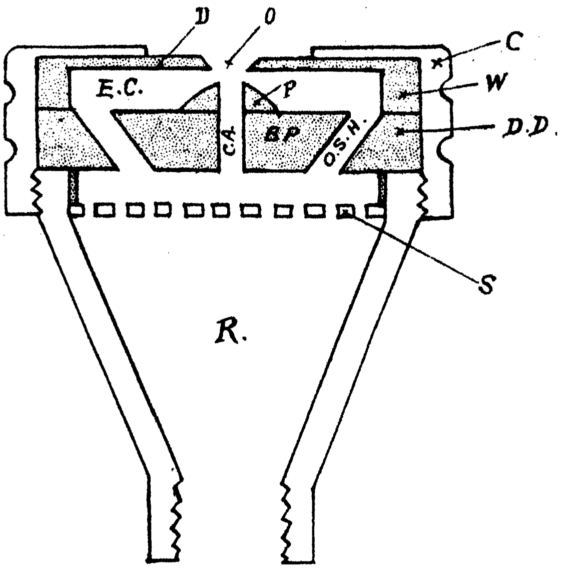
Spraying is an operation that requires careful attention to directions and painstaking, patient execution. Poorly done, the benefits may be nil, or damage may result from the chemicals used. A spraying solution may be effective or ineffective, according to the force with which it is applied, its fineness and the liberality in the quantity used. When the spray accumulates in drops or drips, or runs off, too much is present; on the other hand every part of the plant surface should be covered with a film of spray. Satisfactory results can be secured only by the use of proper equipment, which includes the following:—

1. A nozzle of suitable and efficient construction.
2. The provision of adequate pressure to produce the required types of spraying, to reach as high as necessary, and in the particular direction required, *e.g.*, upwards, underneath the plants.
3. A type of machine suited to the size and conditions of the plantation to be sprayed.

It can safely be said that in all these requirements Australia is many years behind the times. There are various power-spraying plants in operation, but they are not comparable to either the best English or American equipment. Some of the large machines have tanks to hold 200 gallons of wash, and their pumps are capable of delivering up to 2,000 gallons per hour at pressures from 200 to 300 lbs. per square inch. In orchard work these high-power pumps are sometimes connected to a permanent system of iron piping laid so as to supply large areas from a common centre which is near the water supply for mixing the wash. The prepared solution is pumped through the permanent mains, and is delivered by a number of nozzles (*e.g.*, 10 to 16) at one time. This is a most efficient and economical method. The highest and leafiest of trees are now readily sprayed, *e.g.*, the large elm trees in the Capitol grounds at Washington, and various university grounds, to poison the elm leaf beetle (*Galerucella luteola*). A few years ago, had there been any high-power apparatus available, the rows of pines round the Manly Beach, Sydney, could readily have been sprayed to control the Golden Mealy Bug (*Pseudococcus aurilanatus*), which so disfigured the trees that the council had them eradicated.

On the question of nozzles there is also a lamentable ignorance. Many growers know little more than an adjustable Bordeaux nozzle, which is used for all purposes. Although different nozzles are suited to different work, their efficiency depends on their structure and the pressure used in spraying. According to their construction they may be divided into three simple classes after the type of Bordeaux, Vermorel and Disc. The Bordeaux is adjustable by means of a stop-cock, and yields mostly a fan-shaped spray. "Seneca" is a form developed for lime-sulphur spraying. The Vermorel type gives a fine cone-shaped spray, but is very liable to clog, and is not very suitable for large outfits for large orchards. Vermorel, Cyclone, Eureka, Dewey, Vapour Mist are trade names of this type. The most efficient type of nozzle at the present time is the Disc, which has been evolved from the Vermorel. It is larger than the Vermorel, and at the orifice has a disc plate which can be changed when desired to control the size of the outlet. It has a broad, flat chamber into which the liquid is forced through two spiral grooves, having first passed through a strainer. A strong rotary motion is given to the liquid, which breaks up into a fine spray as it leaves the large central orifice or outlet. Trade names are Friend, Atomic, Mystery, Jumbo, Power, Simplex, Tiger, Whirlpool, Spraymotor, Massospray, Scientific, Excellal, and Champion-Variable. There are various modifications of the disc type, and these variations greatly influence the efficiency of the nozzle, which normally gives a hollow cone of spray; that is, it deposits a ring of particles on a given surface. The ring is reduced or the angle of discharge is narrowed with increase of pressure, and at the same time the fineness of the deposit is increased. Some nozzles have a basal plate forming the floor of the eddy chamber with a central hole drilled through it, and the orifice of this hole may be either flush with the surface of the plate or be raised on a conical boss. termed the post. The post, with or without a central hole, is placed below, and directly in line with, the outlet orifice. The central hole converts the hollow cone of spray into a solid cone, diminishes the angle of discharge, and increases the size of the spray particles. The post

produces a more even discharge whether solid or hollow. In this way many of the slight imperfections in the nozzle are overcome. The thickness of the directing disc has an important influence on the distribution. A thin disc increases the angle, and also causes the spray particles to be smaller, or gives a finer deposit.



SECTION OF SPRAY NOZZLE.—DISC TYPE.

C. Cap; C.A. Central Aperture; D. Disc; D.D. Directing Disc; B.P. Basal Plate; E.C. Eddy Chamber; O. Orifice; R. Reservoir; O.S.H. Oblique Supply Hole; P. Post; W. Washer.

It will readily be seen from these brief details how the nozzle may be the cause of success or failure in spraying. It would pay the grower many times over to have several nozzles, each selected for its own special use, and also in cases of accident to his only nozzle in the midst of urgent work. There is no doubt that, at the present time, the growers are in need of much enlightenment on the subject, and much useful co-operation could be effected by the State Departments of Agriculture and the Commonwealth Institute of Science and Industry in the matter of standardization and regulation of all insecticides, fungicides, soil fumigants, animal washes, and dips and powders, and the collection and distribution of information on spraying equipment, and especially nozzles.

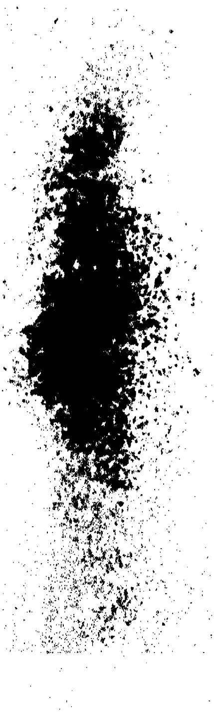


FIG. 1. Showing a Fan-shaped Spray of uneven Distribution. Spray discharged from the Bordeaux Nozzle is similar to this.

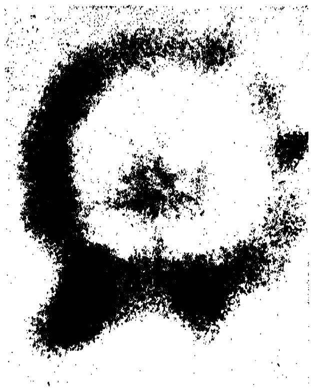


FIG. 2. Showing uneven Distribution of Hollow Cone Spray by a faulty Vermorel Nozzle.

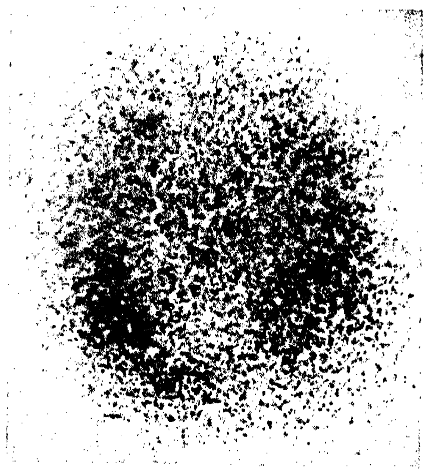


FIG. 3. Showing a Solid Cone of Spray. The Disc Type of Nozzle, having a Central Supply Hole in the Directing Disc, distributes the Spray in a Solid Cone.

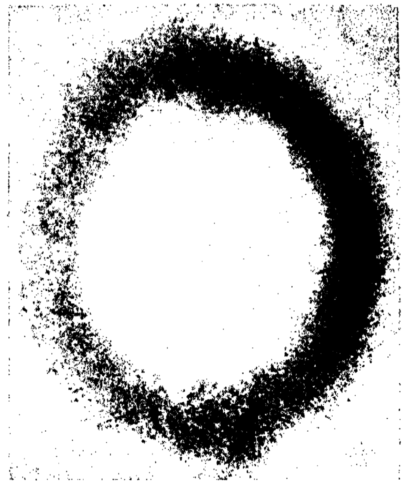


FIG. 4. Showing a Hollow Cone of Spray. Most of the Nozzles of the Disc Type distribute the Spray in this manner.

Research—An Aid to Forest Perpetuation.

By RAPHAEL ZON.

The growth of forest research in North America has been phenomenal. Barely twenty years ago there were no foresters trained in American schools. To-day there are approximately 1,500 trained foresters, graduates of technical schools of high standing, many of whom are devoting their efforts to forest research. Aside from the Federal Departments of Canada, Newfoundland, and the United States, there are now from forty to fifty State, provincial, college, and corporate organizations engaged in the study of problems in forestry and related subjects. The inventory of the North American forest research, just published as a bulletin of the National Research Council, lists some 520 investigative projects in forestry. Such a growth in forest research has not been fostered artificially by generous Government or State appropriations. It is, to a large extent, a spontaneous growth brought about by the needs of the time.

To appreciate the situation one needs only to visualize for a moment the intimate connexion which exists between modern civilization and the use of wood. From the cradle to the grave we depend upon wood. We sleep in wooden beds and walk about on wooden floors of our wooden homes. We wash ourselves with soap made with resin—a product from wood, put on our hose manufactured from wood fibre, and step into our leather shoes cured by tannin extracted from wood. We sit down to breakfast upon a wooden chair in front of a wooden table, read the daily news from a paper made of wood fibre and printed with ink manufactured from a forest product and received over telegraph lines supported by wooden poles. If we are sufficiently prosperous we may go to our office in an automobile with wheels containing wooden spokes, and finally settle in our office surrounded by wooden trimmings and furniture, and dig into the daily letters and reports made of wood pulp. We still travel largely in wooden railroad cars over tracks supported by wooden cross-ties. The commodities which form the necessities of life are delivered to us in containers, some of wood, and some of fibre, but practically all of forest products. About one-fifth of the 276,000 manufacturing plants which serve our needs use wood in one form or another.

As long as our timber supply was ample and could be easily procured by the wood-using industries at a low cost, there was not much thought of conserving either the forests or eliminating waste in the manufacture of forest products. Conditions, however, have now radically changed. The United States, which a few decades ago was the second country in the world as regards the forest area, and ranked first in amount of saw timber produced, has increasing difficulties in providing enough raw materials for the existing lumber and wood-using industries. The 820,000,000 acres of virgin forests of this country have now shrunk to one-sixth of that area. There remain now only

137,000,000 acres of virgin forest. The total forest area, including culled, burned, and cut-over areas, still aggregates some 463,000,000 acres. Of this, however, about 80,000,000 acres have been so severely cut and burned as to become an unproductive waste, and the remainder is in second growth, more than half of which is below saw timber size, and is of relatively inferior quality. The remaining merchantable virgin forests are so distributed as to greatly reduce their national utility. While the bulk of the population and manufacturing industries of the United States are still east of the Great Plains, our remaining virgin forests are on the Pacific Coast. This involves long hauls, and consequently high prices to the industries depending upon wood. There is now consumed or destroyed annually in the United States 56,000,000,000 board feet of material of saw timber size. Our depleted forests are growing less than one-fourth of this amount. The United States is not only cutting heavily into its remaining virgin forest every year, but is also using up the smaller material upon which the future supply of saw timber depends much more rapidly than it is being replaced. The scarcity of high-grade oak, poplar, ash, hickory, walnut, and other standard woods is now placing many American industries in a critical condition. The bulk of the building lumber and structural timbers used in the eastern and central States during the last fifteen years was grown in the pine forests of the south. The virgin pine forests of the South Atlantic and Gulf States have now been reduced to nearly one-sixth of their original stand. The production of yellow pine lumber is now falling off, and within ten years will probably not exceed the requirements of the southern States themselves. Since 1919 the country has ceased being self-supporting in news-print paper, and now imports two-thirds of the pulp, pulp wood, or news-print which we require. In 1919 the production of turpentine and resin had fallen off 50 per cent. Within ten years the United States will lose its commanding position in the world's market for these products, and may, in time, be unable to supply its domestic requirements. As the timber supply has dwindled, the prices, due to the increasing scarcity and long-distance hauls, have steadily gone up. To meet the situation there is need for (1) a change in our present methods of handling the remaining virgin timber lands, so as to prevent their devastation; (2) an increase in the forest productivity of the cut-over or idle land not suitable for agriculture; and (3) the elimination of waste in the handling of the raw material from the log to the finished product. The first two cannot be accomplished without some legislative measures by the Government and States, as it is doubtful if private initiative alone can overcome the economic difficulties in the way of better handling of timber lands. The latter is largely a better knowledge of the product, and can be safely left to the self-interest of the industries. All three measures, however, if they are to be effective, must be based on accurate knowledge of the life of the forest, the best means of its perpetuation, and the properties of wood. The whole present agitation for a national forest programme in the last resort must rest on the work of the men of science, and the solution of such problems as the best method of converting idle land into productive timber land, methods of cutting which will secure either re-growth of the valuable species or the utilization of inferior species in place of the more valuable

kinds whose supply is becoming exhausted, and general improvement in the technical processes of converting wood into other forest products or increasing the yield of by-products from wood.

It is largely under the pressure of the economic necessity of finding a remedy for the growing area of idle forest land that investigations into the possibility of converting it into productive land were undertaken by many States and associations, as for instance, the Southern Pine Association. The Southern Pine Association has recently contributed 10,000 dollars to the National Research Council to investigate the possibilities of cut-over pine land for timber production. This work is now in charge of a forestry committee of the Council, and is well under way. The Federal Government, in its timber operations on the national forests, is trying to solve, through several forest experiment stations in the west, the problems of perpetuation of the forest after cutting by natural means, and by planting up areas destroyed by fire which cannot be brought back into productivity by natural seeding from the older trees. Some of the wood-using industries, although not carrying on forest investigations by themselves, are contributing to some extent, and are keenly interested in the work of the Forest Products Laboratory at Madison, which is solving the many problems of wood utilization, prolonging the life of the material by preservative treatment, increasing the sources of the available products, and discovering new substitutes for valuable kinds which can now be obtained only with great difficulty, and at high prices. Forest research, although still young in this country, has already proved its effectiveness. A few examples may be cited as an illustration. Thus the discovery of the fact that the seed of western white pine—the most valuable specie of our western forests—has a tendency to lie over in the duff for a number of years and germinate after the timber is cut off, and the ground is exposed to heat and sun, has resulted in modifying the timber cutting on the national forests. Instead of leaving 25 per cent. of the total stand as a means of securing natural reproduction, the amount of timber left now is only 10 per cent. This is left more as an insurance against subsequent fires than as a means for re-seeding the cut-over land, which is now dependent upon the seed stored in the ground. The reduction of 15 per cent. in the amount of standing timber, which has an average stand of about 25,000 board feet to the acre, is nearly 4,000 board feet, or at the minimum price of 4 dollars per 1,000, is a net gain of 16 dollars per acre. There are about 850,000 acres of western white pine land which, when cut over, under the new method of marking timber, would represent a gain of nearly 14,000,000 dollars to the Government, as against the old method of cutting.

For years a greater part of western Nebraska was known as the Great American Desert. Aside from a few ranches along the river valleys and low-lying land close to lakes, the land was used for grazing of long-horned cattle that were trailed across the country from Texas, and then sold in the fall of the Missouri River markets. Grazing, however, was so poor that the business proved unprofitable, and twenty years ago there was very little use made of the sand hills. In 1902 206,000 acres of this desert were set aside by presidential proclamation for raising timber. In 1903 the Government established its first plantation. After many failures in the struggle with adverse climatic

conditions, the forest service has developed a successful method of converting the Nebraska bad lands into thriving plantations, and to-day there are about 3,500 acres which have been planted successfully at a cost of about 16 dollars per acre. The weary traveller, passing through the uninteresting sand-hill region in Nebraska, on the Billings Branch of the Burlington railroad, is now astonished, after hours of gazing at bare sand hills, to come suddenly upon green hills covered with evergreen trees. A desert has been converted into a forest which is now becoming a game refuge, and soon will be the playground for people in the prairie country, and a source of timber. This has been accomplished only through persistent research in the face of many discouraging conditions.

There are very few nowadays who will deny the protective value of forest cover on watersheds for irrigation purposes, water-power development, use of water for domestic purposes, and stream regulation and conservation in general. One of the main purposes for which national forests have been used in the west was to secure favorable conditions of water flow. It has been estimated that the service which the national forests perform in the conservation of water for irrigation alone is worth *two and one-half billion dollars annually.* To determine accurately the effect which forest cover has upon the behaviour of streams for the better management of protective mountain forests, the forest service in 1909 undertook an experiment at Wagon Wheel Gap, Colo. Two small watersheds were selected and carefully surveyed as to cover, topography, and geological formation. Dams were built at the mouths of the watersheds, where automatic recording instruments registered the amount of flow throughout the entire year—summer and winter. A net of meteorological observations was established in cooperation with the United States Weather Bureau on both watersheds, covering precipitation, temperature of the air, moisture of the soil and air, evaporation, and snow depth. For ten years no change in the forest cover was made, but last year one of the watersheds was denuded except for a strip of trees along the stream itself. Observations are now to be conducted for a series of years to bring out the effect of forest denudation. As all other conditions were made equal, any change in the flow of the stream from the forested and the deforested watershed must be due to the elimination of the forest cover on one of the watersheds. There is only one other experiment of this kind in the world, and that is in the Swiss Alps, not far from Zurich. The American experiment, however, is more thorough, and the results should be more conclusive, as in the Swiss experiment no water measurements are taken during the winter months, and the two watersheds selected differed from the very beginning in the density of their forest cover, and no denudation of any of the watersheds has taken place. The results of the experiment may be expected within the next five or ten years, as it is desired to carry the observations over a cycle of dry and wet years, and should settle forever the value of forest cover in stream control, and furnish an accurate basis of determining that value in any future engineering projects.

In the field of wood utilization the results so far secured are no less striking. In pulp and paper investigations about thirteen species of American timber, which heretofore were not known to be suitable

for the manufacture of groundwood pulp, have proved to be adapted for such use. In the manufacture of soda pulp the time of cooking, as a result of experimentation, has been reduced by 20 to 60 per cent., thereby making possible an increased production with existing plants of from about 50 to 100 per cent. Laboratory investigations in hardwood distillation have shown that, with no increase in the cost of equipment or operation of a commercial plant, the yield of wood alcohol and acetate of lime may be increased approximately 30 per cent. and 15 per cent. respectively.

The building and construction trade uses annually about 5,500,000,000 feet of timber. This material is worth, roughly, 200,000,000 dollars. Investigations at the Forest Products Laboratory cn the mechanical properties of American woods, have shown that 20 per cent. increases in the allowable strength stresses of structural timbers are permissible. This means the use of smaller timbers, with subsequent saving of raw material, and possible economy in the cost of about 40,000,000 dollars annually. If results are actually applied to only 10 per cent. of such material, the annual saving would still be equal to about 4,000,000 dollars. Improved methods of turpentining, developed by the research workers in forestry, resulted in increased yields and less injury to timber, with a net saving aggregating 4,000,000 dollars a year. Economies in this direction are unlimited. Our present consumption of lumber is around 40,000,000,000 board feet. This represents probably not less than 75,000,000,000 feet of standing timber in the woods. There is an enormous waste between the tree and the finished product. It is roughly estimated that by better methods of utilization based on scientific investigations a saving of over 10,000,000,000 feet is possible. Ten billion feet of ripe timber saved each year means a saving of one year's supply every four years. It means prolonging by 25 per cent. the remaining timber supply. Merely to indicate the possible economies in the use of wood a few illustrations may be mentioned. The railroad and electric lines in this country use about 120,000,000 wooden ties a year. Of this about 28 per cent. are treated with some preservative. The average life of a railroad tie properly treated is fifteen years, of an untreated tie about seven and a-half years. If all ties were treated there would be an annual saving on railroad ties alone amounting to from 1,500,000,000 to 2,000,000,000 board feet a year. If, in addition to the ties, poles, posts, mine props, shingles, and other lumber used under conditions subjected to decay were treated, the annual saving would be increased to some 6,000,000,000 board feet.

The best utilization thus far accomplished under chemical processes in the manufacture of paper is 45 per cent. of the wood substitute. That means that for every cord of wood pulped, some 55 per cent. of the original weight of the wood is lost, and for the total annual consumption, over 2,000,000 cords a year. Now, by proper methods of storing, preventing shrinkage in the weight of wood and loss through decay, a saving of some 600,000 tons of pulpwood might be effected. It is believed that there is an annual loss of 1,000,000,000 feet in the drying of lumber. By proper methods of kiln drying this loss could be cut in two.

RESEARCH—AN AID TO FOREST PERPETUATION.

Important as are the results already accomplished by forest research in this country, they appear extremely small as compared with the enormous size of the industry depending upon wood, and the vital interests of the country as a whole. The lumber and wood-using industries are among the greatest and most important manufacturing industrial developments of the country. Of the various industries they rank second in invested capital, first in labour employed, and second in annual value of products. Yet the total appropriation for forest research in this country barely exceeds 600,000 dollars a year, covering all the activities—Government, State, college, and individual. This is less than one-hundredth of 1 per cent. Compared with the expenditures of research of such industries as the steel, chemical, telephone, and photographic industries, &c., the wood-using industries of this country have not begun to realize the possibilities through research.

Cornell University, U.S.A., has received a bequest of £100,000 as an endowment to promote Research.

We learn from *Nature* that Mr. John Quiller Rowett has contributed £10,000 towards the endowment of an Institute for Research in Animal Nutrition in connexion with the University of Aberdeen and the North of Scotland College of Agriculture. The new institute, which will be named Rowett Research Institute, has secured the services of Dr. J. B. Orr, the Director, recently associated with Professor E. P. Cathcart in the conduct of a study of the energy output of soldiers, and Dr. R. H. A. Plimmer, Chief Biochemist in the Institute, a research worker in the Physiological Institute of University College, London.

The Dingo Question.

By A. S. LE SOUEF, Taronga Park, Sydney.

Just when the dingo arrived in Australia is only of academic interest; the fact that he is here, and a serious menace to our pastoral industry, is of immediate vital concern.

The dingo is a true dog, specialized into an even type, an average male being 42 inches from head to tip of tail, and standing 21 inches at the shoulder, having rather long, coarse, tawny hair, with a white-tipped, short, brush tail, and short, prick ears. A white race is found in Southern Australia, between Port Augusta and Kalgoorlie, and black specimens have been noted in the north-west. The dingo cannot bark.

Pure animals are now rare, as they have been crossed with the domestic dog, and nearly all that are now killed show admixture, chiefly in having white paws, white mark on chest, shorter coat, sometimes drooping ears, and often larger size.

While generally spread all over the country they are confined chiefly to the wilder hilly parts and forest areas, which offer them greater security than the plains, but in the absence of timber they will lie up in scrub and gullies, but this is only the day refuge, for they come out at night into the more open lands in search of food, but they seldom go far into the plains.

Broadly speaking, the wild dog is now numerous in the north and north-west, and also in the mountain country of the south-east of New South Wales; in the south and west of Queensland; over a large part of the Northern Territory; and over a considerable part of Western Australia, especially in the north-west and south-west. They breed up in the uninhabited interior, and a continual influx occurs into the settled parts. An attempt was made to fence them off from New South Wales in the north-west, but during the war the fence fell into disrepair, and the prevailing drought drove numbers of dogs eastwards.

Having only small animals to deal with they hunt singly or in pairs, and sometimes in small packs, but this is generally a female with her grown pups.

The young are born in late winter, about August, but the time varies in different parts of the country, being later in the south than in the north; the female generally selects a cave or isolated hollow log in which to rear her family.

In the uninhabited country their food consists of marsupials, birds, reptiles, &c., and they form a natural check on the undue increase of the kangaroo and wallaby, and, to a lesser extent, of the rat kangaroo and the bandicoot, and for this reason the dingo is sometimes tolerated or even encouraged in cattle country, but this is uneconomic, for with a little knowledge of their habits the offending marsupials can be killed and the value of their skins will well repay for the work. The position is also unsound in that when other food fails the dogs attack calves and foals, or migrate to the surrounding sheep country.

THE DINGO QUESTION.

The losses caused to the flocks of the Commonwealth are very serious, and, of late years, have been increasing to such an extent in certain pastoral districts of New South Wales, Queensland, and Western Australia that many station-holders have had to abandon sheep and stock with cattle. If the present conditions are allowed to continue a serious and permanent reduction of our flocks will take place, and a corresponding loss to the national revenue.

The effective control of the wild dogs is hampered, in that there is no co-ordinate action between the various States, and between the States and the Commonwealth, nor has the question been specially investigated with a view of finding out the best means of combating the pest. The means that are adopted are much the same in all the States.

The Pastoral Protection Boards offer a bonus for dogs killed; this is sometimes supplemented by the Government, and a special payment is often made by the settlers for the destruction of a noted dog that is causing special damage. The actual destruction of the dogs, and the means taken, are in the hands of the settlers themselves, though one will often find men who specialize on the work, and some of these are very expert, and jealously guard any knowledge they may have gained in this direction.

In discussing various methods for killing dogs it must be understood that great variation can be used to suit special conditions, the peculiarities of certain animals, and also for the time of the year. Generally speaking, most good can be done in the spring and summer when the pups are abroad, for the young and inexperienced dogs are easily got, while the older animals are much more difficult, and some are exceedingly clever, and seem to have learnt all there is to know about traps, and poison, and human ways generally; then it is a case for man's ingenuity against the dog's cunning.

The general ways of destroying wild dogs are by shooting (often combined with driving and hunting with trained hounds), trapping and poisoning; but in applying any method the habits of the animals must be taken into consideration. The dingo is a wary beast, which travels with every sense alert, and is gifted with a very keen sense of smell. Strange objects are always investigated and approached with the utmost care, anything handled by man is left alone, and even man's tracks may not be crossed. He will follow a trail, track, or fence, and generally go to and fro from lair to hunting fields by the same track; they must drink once in twenty-four hours. When on game the dingo becomes reckless, and when among sheep frequently kills or maims a dozen or more. Individual animals will often develop special habits, or show some peculiarities, and the study of these may give the clue to the best way of getting them. They usually attack a sheep's flanks, and feed from the hind quarters.

Shooting is effective when the dingoes are confined to comparatively small areas of forest or scrub which enables them to be driven up to posted "guns," which must be placed to leeward of the quarry so that they will not scent the man ahead. This requires very careful management and knowledge of the lay of the country, tracks, &c.

In the winter and spring trained dogs can follow the wild animals and often bail them up or kill them, and they may trace them back to the den where the pups are hidden.

It is essential in poisoning that none of the ingredients used be touched by human hands; the baits should be laid from horseback, as a man's tracks cause suspicion. If poison is put into a carcass (to which females in whelp and young dogs will often return) the poison should be placed in the flesh round the flanks and buttocks, the hole being made with a sharp stick, and only a quarter of a grain of strychnine placed therein; this will adhere to the damp stick which can be reinserted into the hole, and the poison will remain in the flesh when it is withdrawn again. Small animals, such as a rabbit, can be poisoned and laid on a trail, or balls of fat in which strychnine has been placed laid on the trail made by dragging a sheepskin. The fat or lard must be taken out of the pot with a spoon and the poison placed therein, and the piece dropped into a can of water, from which it is removed by a wooden spoon again when required.

The catching of wild dogs is an art in which there is room for infinite variations, individual care and neatness of work, but the main considerations are: The traps must be free from human and iron scent; all rust must be cleaned off, and the trap boiled for twenty minutes in clean water, but a little unslacked lime in the water will make a better job. The subsequent handling must be done with a stick or other clean tool. Fasten the trap to a log weighing about 30 lbs., so that it can be dragged, otherwise the foot may be pulled out. If a large, strong dog is suspected put a little strychnined fat on top of the jaws of the trap so that the dog, in biting at the trap, will get the poison, and then, if the paw is bitten off as sometimes occurs with a very determined old dog, he will be poisoned in any case. If possible set the trap with hands gloved and feet encased in sheepskin shoes, or drop a skin on the ground, dismount from the horse on to it, and set the trap while standing on it, and take away when remounted; if this cannot be done cover the trap with bushes for two or three days until all scent is gone, and then uncover and place the lure in position.

Of course a bait is never placed in or on a trap, but usually a little distance away, and in such a position that a dog approaching the lure would walk into the trap. The dog's attention is focussed on the lure, and a trap, if not smelt, is unsuspected. Almost anything of animal nature will do for a lure if the trap is near a track that the dog is expected to follow. Fresh dog dung is very effective, but if it is necessary to draw a dog some distance to the trap then a stronger scent must be used.

If a dog is found to follow a certain path in going to and fro from the feeding grounds a log can often be found that by long habit he will be jumping carelessly over, and a trap placed on the far side of this will be successful. If there is not one handy, a log can be placed across the track, and although a dog will never jump over anything strange, still he will, when quite familiar with the obstruction, jump over it, and then the trap can be placed in position.

A useful "set" for a track is to place an obvious trap in the centre of the path and two well hidden traps at each side; the dog's attention will be given to the centre object which he will carefully walk round and will step into the side traps.

What is known as the "water set" is more useful for foxes than dingoes, but it can be used for them if the water is fairly deep, for a dog will readily walk into shallow water, especially in the hot weather. A lure is placed well out of the dog's reach from the bank of a stream or waterhole, and a trap set under water and covered with moss or *débris* in such a position that it forms a convenient step to reach the lure.

In sandy country the aborigines will be found most useful in tracking down and killing dingoes; their instinct for this work is wonderful, and they frequently walk up to a dog when he is asleep and shoot or spear him.

A dog that is poison and trap shy can sometimes be brought to book by placing strychnined fat on the wool of a sheep's neck and allow it out where it is likely to be attacked; in the excitement of the chase the dog would not notice the bitterness of the drug until too late.

The wild dogs seem to be free from any special disease, and the probable limit to their numbers is the available food supply; though, doubtless, some of the puppies are killed by eagles, owls, and snakes, but they should be susceptible to distemper, a common disease confined to canines. This is well worth investigation, for if the disease could be communicated to the old dogs in the spring they would, in turn, give it to the young puppies, and great numbers might be easily destroyed. Distemper does not readily affect old dogs, but is deadly to young ones. To obtain and maintain in virulent condition the germs of this disease would not be an easy matter, and then the common dog type may not affect the dingo. An outbreak of distemper occurred some years ago among the jackals and wild dogs in Africa, and caused great mortality. Valuable dogs can easily be made immune by an injection of the protective serum.

Some Australian Essential Oils.

By JOHN K. BLOGG.

In commenting upon the subject of Australian essential oils, it is important to consider their value as a commodity for export. Contributions to the exports from Australia do the State a good service. Especially is this true at the present time, when it is so desirable to have credits on the foreign market wherewith to meet debits we incur, or wish to incur. While the essential oils from Australian indigenous products would never at any time run into big figures, if they contribute their full quota the sum will not be an insignificant amount.

The most valuable essential oil that Australia can produce without special cultivation is that of the *Backhousia citriodora*, a native of Queensland. This oil is the most prolific of citral of any known variety; indeed, it consists almost entirely of citral*. It is practically free from terpenes†. Citral is the element of flavour contained in essential oil of lemon, though to the extent of only 5 per cent. or, perhaps, a little more; yet for the sake of this small quantity of flavouring matter, large quantities of oil of lemon are produced in Italy and other places.

It is true that citral is derived from other sources, such, for instance, as lemon grass, *Cymbopogon citratus* and *Cymbopogon flexuosus*; the former from Ceylon and Straits Settlements, and the latter from Malabar. Essential oil of lemon grass yields 70 per cent. to 85 per cent. of citral; its chief use is for the manufacture of perfumery, and since the discovery of a process for converting it into ionone, it is very largely used for that purpose. Ionone possesses an intense odour of violets; even a microscopic portion of it will fill a large room with its perfume. The demand for ionone under various fancy names has increased so enormously that the oil of lemon grass produced is now insufficient for the world's requirements. Manufacturers have had to pay constantly increased prices, though the area of the cultivation of the plant has been much enlarged. Any other essential oil that would yield a high percentage of citral should be able to command a very fair return to the distiller. The present price of citral is 35s. per lb. in London. In *Backhousia citriodora* we have an indigenous source of citral, with the world waiting for it. Can it be that this source of citral is neglected through ignorance of it? The Germans are not ignorant of it; and, but for the war, a German firm that had sent a scientific observer to spy out Australian products of value, had made arrangements to distil this very oil in Australia, and export it to Germany. Ionone is a most difficult synthetic perfume to produce. I have not heard of any one in Australia, beside myself, who has succeeded; failure being probably due to inaccuracies in carrying out the routine of the sequent steps toward its production. In manufacturing ionone from the essential oil of *Backhousia citriodora*, at the time of writing, I believe my operation to be unique. My first step was to extract the pure citral from the essential oil, reserving the terpenes and resinoid for future observation. The extraction of the citral may

* Gildermister and Hoffman. *The Volatile Oils* 1913.
† Ernest J. Parry. *The Chemistry of Essential Oils* 1906.

be accomplished in two ways; the one, by careful fractional distillation, and the other, by what is known as the bisulphite method. For myself, I prefer the fractional distillation process, and I have tried both. What little terpene the oil contains may be withdrawn at a temperature below 110°C. at a pressure of 14 M.M., or below 117°C. at 20 M.M. When the terpene ceases to drop, and it should never be distilled at a greater speed than 60 drops per minute, the temperature may be raised, and the distillate directed into another receiver. Distillation is continued until the citral ceases to come over at 112°C. at 12 M.M. It is usual with writers on the subject to recommend the distillation of the citral with steam, after the terpenes have first been removed from the oil by fractionation, but I have found the product not so satisfactory, some of the resinoids being assisted over with the steam.

I have found a fractionating column with four bulbs the most satisfactory, and if pieces of pumicestone are placed in the distilling flask there will be no "bumping." The bisulphite method depends on the property of the aldehyde citral to combine with a hot 30 per cent. solution of bisulphite of soda; the other constituents of the oil remaining uncombined. These latter must be carefully removed by filtration and washed out with benzene, the application of an aspirator or vacuum pump being necessary to remove the last trace of benzene. The solid or concrete mass is now placed in a warm solution of carbonate of soda; this causes disunion of the citral and bisulphite, the former floating on the solution, from which it may be easily separated. The next step is the condensation of the citral to a ketone; this is accomplished by dissolving the citral in an equal volume of acetone, and adding thereto a solution of hydrate of barium; this mixture must be frequently agitated during seven days to complete the condensation. After a short repose, the solution of barium is removed, and the product of the reaction dissolved in ether, and separated; on the ether being evaporated the residue is fractionally distilled under reduced pressure of 12 M.M., and the fraction distilling at a temperature of 138°C. to 150°C. is collected, any unattacked citral and unchanged acetone being removed by a current of steam. The remaining ketone must now be carefully purified by fractional distillation in vacuo under a pressure of 12 M.M.; the liquid that distils off at a temperature of 142°C. to 145°C. is reserved. This liquid is called "pseudo-ionone," and has the formula $C_{13}H_{20}O$. It now has to be converted to ionone by being heated for about seven hours in an oil bath, with water, sulphuric acid, and glycerol in suitable proportions, a reflux condenser to prevent loss by evaporation being affixed. The product of this reaction must now be separated with ether, the latter evaporated, and the residue fractionated in vacuo. The fraction distilling under a pressure of 12 M.M. at a temperature of 125°C. to 135°C. is collected. If all the foregoing conditions are properly carried out ionone will be produced.

Citral can be converted to other commodities beside ionone; it is largely used by distillers of inferior oil of lemon to raise the citral content of their product. The terpenes that are a by-product in the manufacture of terpeneless oil of lemon are again used for the manufacture of fictitious oil of lemon, citral being added to supply the deficiency.

It is not my purpose to expose business chicaneries or trade secrets, but these must be subservient to the matter in hand, viz., to show the importance of the products to which I refer.

There are other Australian essential oils that contain citral—*Eucalyptus staigeriana* (the lemon-scented ironbark of Queensland), and *Leptospermum liversidgei* (the lemon-scented teatree)—but not to such an extent as the *Backhousia citriodora.*

The essential oil of *Eucalyptus macarthuri* is another product that should have an exportable value. The chief constituent of this oil is geranyl acetate. From this product can be obtained some very useful perfumery substances, such as geraniol and rhodinol; the latter is one of the chief constituents of attar of roses. I have eliminated this very product, and produced some artificial attar of roses, the odour of which experts have been unable to distinguish from that of a living bloom of the Balkan oil rose (*Rosa damascena trigentipetala*), a few bushes of which I have growing. Geraniol and rhodinol are usually extracted from essential oils that can be and are used in their natural condition for perfumery purposes; but these would not be likely to be broken down if a supply of oil of *Eucalyptus macarthuri* were obtainable. It would be better economy to break down essential oils that are much less useful in their natural state than to derive the higher products from oils that already serve a useful purpose as they are. *Eucalyptus macarthuri* is commonly known as Paddy's River box, or Camden woolly butt, confined to the counties of Camden and Argyle, New South Wales. According to Messrs. Smith and Baker, the leaves and branchlets yield 0.112 per cent. of crude oil, consisting principally of the ester geranyl-acetate. The leaves distilled in June, July, and August yield oil of a higher ester content, containing less terpenes, the maximum of ester being about 75 per cent.

Eucalyptus citriodora, known as the "citron-scented gum," found principally in the north coast district of Queensland, is another of our most important eucalyptus oil species. Those who have had experience in dealing with the leaves of this variety report a yield of 0.586 per cent. of oil, consisting of 80-90 per cent. of the aldehyde citronellal $C_{10}H_{18}O$. This aldehyde is easily reduced to the olefinic alcohol citronellol $C_{10}H_{20}O$ with sodium amalgam or zinc dust. Citronellol is a very important constituent of attar of rose, and is used largely in the manufacture of perfumery.

My experience in the manufacture of citronellol from essential oil of *Eucalyptus citriodora* convinces me that ordinary care is all that is necessary in following out either of the methods usually adopted for the separation of aldehydes from essential oils containing them. Technical books upon the subject recommend the bisulphite method, and no doubt it affords a very direct way of demonstrating qualitative contents; but for practical purposes I prefer fractionation under reduced pressure as being more economical and satisfactory as regards the conservation of the by-products. I have produced citronella $C_{10}H_{18}O$, the purity of which is proved by the reduction thereof with sodium amalgam to the alcohol citronellol $C_{10}H_{20}O$, the odour of which left nothing to be desired, and on re-distilling the product under reduced pressure, there was no residue.

Some of the essential oils to which I have referred are already being distilled in Australia, but to such a restricted extent that the volume is altogether too small, and the price, in consequence, too high to admit of their being used commercially for the purposes of synthetics products. It is only tantalizing to manufacturers who would patronize Australian products to find that the moment they are ready to operate the products are unobtainable. I commenced the manufacture of ionone from essential oil of *Backhousia citriodora,* and produced an excellent product; suddenly I found the essential oil unobtainable, and I actually re-imported from England about 50 lbs. of it that had been sent there for sale. The nature of this essential oil was not known in England at the time, otherwise I would have been unable to buy it at the price paid. Surely this should have been an indication to the original distillers that the oil was wanted.

The Necessity for Research in the Oil-Shale Industry.

An Account of the Shale-Oil Industry as Developed in Scotland—Steam-Regulated Pyrolytic Distillation—Quality and Quantity of Oil Yields—New and Improved Practice should be Developed from Old Operation.

By MARTIN J. GAVIN.*

One rarely reads a technical or oil-trade journal without coming across some article or statement regarding oil shale. We are told of the enormous supplies of this material within the borders of the United States, of the plants to treat shale that are operating or under construction or about to be constructed, of the companies organized to produce and refine oil and other products from oil shale, and commonly of the huge profits to be made on small investments in oil-shale operations. Supplementing these articles, the country has been well covered with oil-shale company promotion literature, commonly of a still more optimistic and often misleading nature. The public apparently has been led to believe that the American oil-shale industry is a going one —that is, plants are making and refining shale oil on a successful commercial scale—and that money is actually being made in oil-shale operations by marketing shale oil and its products.

Shale-Oil Industry Activity.

The writer does not desire to discourage the proper kind of activity in connexion with oil shale, because the time is growing near when shale-oil products will undoubtedly be necessary to supplant in part our present petroleum supplies, and he believes that in the course of a comparatively short time oil-shale operations, if properly conducted and financed, can be made commercially successful. It is desired in this paper to indicate particularly the great necessity of properly conducted scientific research and control work on oil shale and shale oils, without which it would be indeed difficult to carry on oil-shale operations successfully.

At the present time there are, strictly speaking, no commercial oil-shale operations under way in the United States. There have been perhaps eighteen or twenty shale retorts erected in the country and most are in intermittent operations from time to time for experimental or demonstration purposes, but with one or two possible exceptions these are too small to give much of an idea of their commercial feasibility. Nearly if not quite 150 companies have been organized in connexion with oil shale, many of which, unfortunately, are purely stock promotion concerns. Some are actually engaged in experimental work of a sort, and a very few are actually conducting well-planned and organized investigational and research work.

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Greater Co-operation among Investigators Needed.

There is very seldom a laboratory at the experimental plants, and only infrequently a well-trained technical employee. Except in a very few cases, shale oils produced in the small plants have never been given more than very superficial inspection and the real quality of the oil made is generally unknown even to the operators themselves. There is little spirit of co-operation among the oil-shale operators, each apparently believing his idea of a shale retort to be far superior to all others. In passing, the writer expresses as his opinion that mutual helpfulness and co-operation will go a long way in the building of a successful oil-shale industry in this country, as there is so much work to be done and so many problems to be solved that no one individual or company can hope to do it all.

Not Enough Continuous Experimental Work.

Experimental work in connexion with oil shale, again, with one or two notable exceptions, has so far consisted in the construction of a retort, usually designed along lines as different as possible from the well-known Scotch type of retort, and its operation at maximum capacity until a certain lot is run through; then it is shut down until another lot is ready for testing.

Rarely is attention paid to the quality of oil produced. As far as the writer knows, none of the plants has been operated long enough or under such conditions as would give an idea of its life in commercial practice. A run is usually considered successful if oil is produced and the residual shale yields practically no more oil. There are practically no recognized retorting methods and usually, in any particular type of retort, all shales are treated under the same more or less accidental conditions.

As a rule the retorts are designed with the idea of removing oil vapours from the retort as soon as they are formed, but this idea is not always carried out. Most retorts builders try to get as far away from Scotch practice as possible and though many use steam in retorting, the quantity used is so small or it is applied under such conditions that it gives negligible results.

The Scotch Practice.

For a proper understanding of problems in shale-oil production and refining, it is desirable that Scotch practice in this regard be outlined, as it is generally not well known, or its principles are misinterpreted.

In the following discussion the writer wishes it to be understood that he does not believe Scotch oil-shale retorts and operations to be the last word in the oil-shale industry. It is reasonable to believe that types of retorts and practices different from those employed in Scotland may be developed in this country more particularly adapted to American shales and conditions. It is emphasized, however, that the Scotch oil-shale industry is really the only commercially successful oil-shale industry in the world at the present time and that it has been successful for more than sixty years. This being the case, the logical first step

in the development of an oil-shale industry in the United States, a new art here, would be an attempt to apply the apparatus and practices now used in the country where oil-shale operators have reached their highest development. If Scotch methods are not found satisfactory in this country, it may be possible to modify them, and even if modifications are unsuccessful, the knowledge of Scotch shale operators, based on over sixty years of practical experience, cannot reasonably be disregarded but logically should serve as points of reference.

In Scotland the shale brought from the mine is crushed by toothed rolls into pieces of average size of an ordinary brick; as a rule everything going through the rolls goes to the retort.

Scotch Retorts.

From the breakers the shale is carried in cars up an incline to the top of the retorts, where it is dumped into the retort hoppers by hand. The most commonly used Scotch retorts are vertical and tapered, consisting of the following parts:—At the top there is a hopper, which holds several hours' supply of shale. Below the hopper is a cast-iron upper part which is about 12 feet in length and which has a vapour outlet near the top. Under the cast-iron part, and joined to it with a fireclay joint, is the lower masonry part, which is about 18 feet high and made of a single tier of very special-shaped firebrick. At the bottom of this part is the discharge mechanism and below that the spent-shale hopper, which serves one or two retorts and in which the spent shale accumulates. The cast-iron part is made circular or elliptical in cross-section, and the masonry part square or circular. Those of circular cross-section have an internal diameter of about 2 feet at the top and 3 feet at the bottom. The taper is constant.

Each retort, with its supply hopper, holds about 9 tons of shale and the feed is by gravity. Four retorts, as described, are set in a common furnace and are heated by the combustion of the fixed gases resulting from the distillation of the shale, supplemented by coal producer gas when necessary. Four retorts are a unit, and sixteen such units constitute a bench, two retorts wide and thirty-two retorts long. The present retort working on shale now being mined in Scotland has a capacity of about 4½ short tons per day. Tests indicate that the retort capacity is a function of oil production rather than shale throughput. Apparently a Scotch retort will produce approximately 100 gallons of oil a day, whether it is working on a 10-gallon shale or 100-gallon shale. In the former case approximately 10 tons can be put through; in the latter but one.

In the upper or cast-iron part of the retort most of the oil distills and the maximum temperature in this part does not exceed 900 degs. F. The lower or masonry part serves mainly as an ammonia and gas producer. About 105 gallons of water, as exhaust steam, for each 25 gallons of oil produced, is admitted into the spent-shale hopper and passes up through the shale in the retort. The steam serves to absorb the heat from the spent shale, to produce water gas from the fixed carbon remaining in the spent shale, to distribute evenly the heat in the retort, to produce ammonia from the nitrogen of the shale, and to carry

off the oil products formed. Distillation with steam increases the yield of ammonia about two and one-half times as compared with dry distillation, and also produces more oil which is of higher quality.

Temperature and Heats.

The maximum temperature to which the shale is subjected is not much in excess of 1,500 degs. F., although temperature measurements have never been accurately made within the retort itself. The retort operators are skilled in judging retort temperatures by heat colours, and keep temperatures under careful control by looking into the furnace through peepholes. In general, in retorting and refining practice in Scotland, one is struck with the very definite way conditions are controlled. Many years of practical experience have determined these conditions.

The spent shale is discharged continuously from the retorts, and the mechanisms used for this purpose constitute the main points of difference between the types of retorts. The spent shale is refuse. No commercial use has ever been found for it, although it has been tried in road and brick making. The fixed carbon remaining in the shale amounts to only 1½ to 2 per cent. This is the economic limit with reference to fuel consumption, throughput of shale, and ammonia and gas yield. A greater yield of ammonia could be obtained by reducing the amount of carbon, but at the expense of throughput.

Vapours Separated from Gases and Refined.

Vapours pass out of the retort through the vapour line, which is cast integral with the upper part of the retort. Large suction fans in the dry gas main, between the scrubbers and gas burners, put a slight suction on the retorts. The vapours pass to large headers and thence to a series of U-shaped, vertical, air-cooled condensers made of cast-iron pipe. Below each U is a receiving box for condensate, and from this box the condensed oil and ammonia water are drawn off to separating tanks. Uncondensed gases pass through water scrubbers, which remove any ammonia remaining in the permanent gases, and through oil scrubbers, which remove the light hydro-carbons, commonly known as "scrubber naphtha." The gas is then led back to the retort furnaces, where it is burned.

Shale now being worked in Scotland yields per short ton approximately 10,000 cubic feet of gas having a heat value of about 240 B.t.u. per 1,000 cubic feet, approximately 24.5 U.S. gallon of crude oil, and 36 lbs. of ammonia sulphate.

The crude oil, after having the bulk of the water separated, is run to the refinery. The refining of this oil is more involved and complicated than the refining of petroleum, as the oil must be subjected to more acid and alkali treatments and a greater number of distillations. Therefore a shale-oil refinery contains more small stills and agitators than does a petroleum refinery of equal capacity. More batch stills are used than continuous stills, and the Scotch shale-oil refineries have extraordinary large wax plants compared with petroleum refineries of equal capacity.

Flow Sheet of Products and Plant Lay-out.

Practically all refinery distillations are conducted with a large quantity of steam, which is admitted into the bottoms of the stills. The crude oil is run to coke, as are also some of the redistilled oils.

The yield of refined products in Scotland is somewhat as follows:—

	Per cent.
Naphtha (including scrubber naphtha) 54 deg. end point ..	9.9
Burning oils (kerosene and the like)	24.7
Gas and fuel oils	24.4
Lubricating oils	6.7
Wax	9.5
Still coke	2.0
Loss	22.8
	100.0

A general idea of the complexity of shale-oil refining in Scotland can be gained by referring to Fig. 1, a generalized flow sheet of refinery operations at a typical Scotch shale works. This figure and Fig. 3 are presented through the courtesy of Scottish Oils Ltd. The writer wishes to express his appreciation particularly to H. R. J. Conacher of this organization for the use of these figures.

Scrubber naphtha, which is the gasoline or naphtha recovered from the retort gases by washing them with oil and subsequently distilling the latter, amounts roughly to 2.4 gallons per ton of shale.

Ammonia water from condensers and scrubbers is run to ordinary continuous ammonia stills. Ammonia gases pass off and are dissolved in dilute sulphuric acid, much of which is recovered from the acid tars. The sulphate solution is concentrated by a continuous system and is finally purified and sold as crystalline ammonium sulphate.

Fig. 2 is a plan of a typical modern Scotch oil-shale works, including retorting plant, oil refinery and ammonium sulphate plant, with accessories. It serves to indicate the outlay and equipment necessary in the production and marketing of refined oil-shale products, and gives an idea of the scale under which Scotch operations are carried on. Such a plant represents the investment of several millions of dollars.

The principal objection in the minds of American shale operators to the Scotch retort is its low throughput and its use of steam. Scotch operators find that it is necessary to heat their shale slowly and to use plenty of steam if a satisfactory oil is to be produced, and the past tendency in Scotch practice has been to lengthen the time of treatment and use more and more steam. As a matter of fact, the amount of steam used is largely determined by the amount of oil a shale will yield. Rapid production of oil from Scotch shale has meant that an oil of poor quality resulted, though not enough work has been done on American shales to determine if they will behave the same way.

The use of steam in retorting apparently does so much more than merely produce ammonia that its use cannot be abandoned without

further consideration even if ammonia recovery is not desired. The spent shale coming from the Scotch retorts is very hot (perhaps 1500 degrees F.) and if not steamed would be discharged in that condition and contain from 6 to 10 per cent. of fixed carbon the fuel value of which would be wasted. The use of steam, as described, cools the shale, while heating the steam, thus carrying heat back into the retort; in

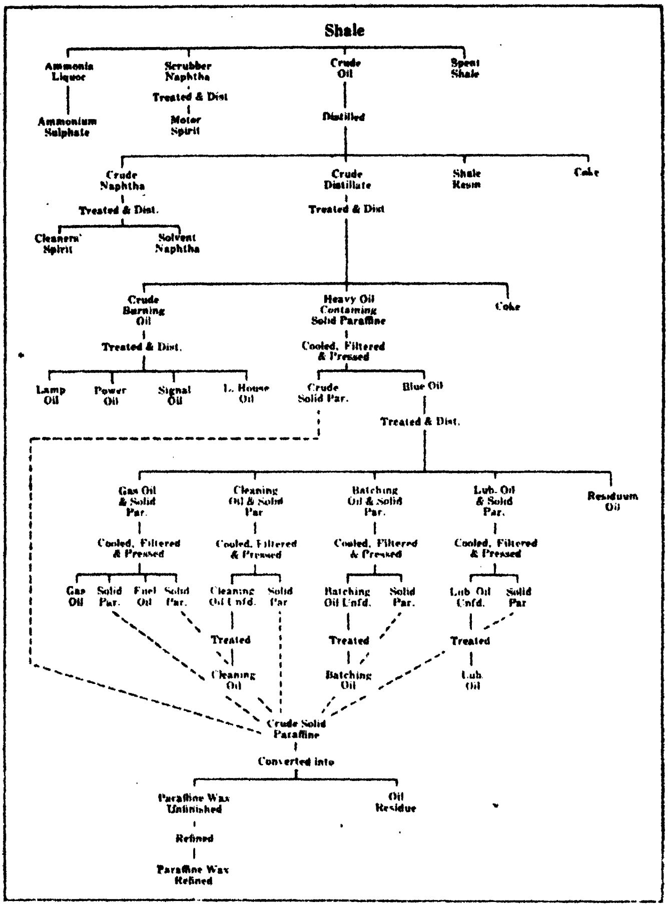


FIG. 1. FLOW SHEET OF SCOTCH REFINERY OPERATIONS.

addition, the steam and fixed carbon in the shale react, producing a gas of good fuel value, since it is composed mostly of hydrogen and carbon monoxide, thus utilizing much of the fuel value of the fixed carbon in the spent shale. As the carbon is burned out, ammonia is produced, and the excess steam and other gases protect the ammonia from decomposition at the high retort temperatures, and sweep it at once into the cooler zone. Oil production in the upper part of the retort goes on

slowly and oil vapours made are at once swept away to a cooler zone and out of the retort by the excess steam and gas, thus effectively protecting the oil from excessive decomposition.

By-Product Ammonia.

The question of producing ammonia from oil shale is one that has been discussed at considerable length by those interested in oil shale in this country. The average American oil shale compares favorably with Scotch shale in nitrogen content, and it is to be expected that the nitrogen in both shales can be recovered with equal ease. The general tendency among American oil-shale processes seems to disregard ammonia recovery except the small amounts incidentally produced in ordinary dry destructive distillation. It is felt by many that the conversion of the nitrogen in a rich oil-yielding shale into ammonia is not a desirable thing, as such conversion would reduce the retort capacity for oil. While this is probably the case, there is nevertheless a fair probability that the increased returns made by producing ammonia would more than counterbalance the decreased oil-producing capacity of the retort, assuming a satisfactory market for the ammonia exists. This may particularly apply if it is found that steaming the retorts is necessary to produce the best grade of oil. To produce maximum economic yields of ammonia from oil shale, Scotch operators find a maximum temperature of about 1,500 degrees F. and an excess of steam necessary. While 900 to 1,000 degrees seems to be the highest temperature necessary to produce oil from oil shale, the increased heat needed to produce the ammonia is nearly if not completely supplied by the combustion of the gas produced by the action of steam on the carbon of the shale in the ammonia-production part of the retort.

The use of steam in retorting is said by the Scotch operators to increase the yield of ammonia over two and one-half times the amount recovered by straight dry destructive distillation. In discussing the ammonia-recovery problem, it is necessary to point out the possibility of recovering part or all the nitrogen of the shales in some form other than ammonia, such as pyridine compounds and the like, and also the conducting of the oil-recovery and nitrogen-recovery operations in separate and more or less independent apparatus. Both of these possibilities require thorough study, and whatever is done in the way of recovering nitrogen must take into account the main purpose of oil-shale treatment—that is, oil production.

Quality and Quantity of Yield.

The writer has examined oils from Scotch plants and oils produced by different processes from various American shales, and has found that the quality of the Scotch oil is in every way much better than any oil he has thus far seen from American shales. Whether this is mostly due to the nature of the processes or to the shales themselves he is not definitely prepared to say, although it is known that the conditions under which oil is produced from shale have a very decided influence on the quality and quantity of oil yield. However, it has also been determined that different shales, retorted under identical conditions, do yield somewhat different oils. Both factors undoubtedly influence the quality of the oils yielded to a considerable extent.

The problem of those working in oil shale seems to be the production and subsequent refining of the best possible quality of shale oil consistent with economic practice. Once these conditions have been determined, they must be controlled and held as uniform as possible in commercial practice. The quality of oil produced will perhaps depend on the kind and amount of products desired, but it seems that the crude oil should be obtained in as undecomposed or uncracked a state as possible. This has plainly been the aim of the Scotch operators. Every successful change in Scotch retort design can be noted in the greater production of burning oils and wax from the Scotch crude, a plain indication of less cracking.

Perhaps, in the United States, it may be desired to obtain a greater yield of gasoline or light oils by cracking the crude shale oil. Even then it would appear that the crude should be obtained from the retort in as uncracked a state as possible, and only those fractions of the crude most adapted for cracking be so treated. Cracking the crude itself, either during production or subsequently, can reasonably be expected to yield more light oils, but at the expense of some of the desirable heavy fractions of the crude. The production of a crude yielding a maximum amount of gasoline directly from the retort is thus apt to be a decidedly wasteful and uneconomical practice and, moreover, likely to yield a very unsatisfactory grade of gasoline, since the cracking of the crude during production cannot be so easily controlled as the cracking of a selected fraction in a separate apparatus designed solely for cracking, where exact control is possible.

As a rule, American shale oils thus far examined differ from the Scotch crude in that the former are heavier (specific gravity 0.900 to 0.980) than the latter (specific gravity 0.875), fractions from the former are more highly unsaturated and the odour more disagreeable than those from the Scotch crude. The American shale oils thus far examined were of a mixed paraffin and asphalt base, while the Scotch oil is distinctly of a paraffin base. It may not be possible to make as good oils from American shales as from Scotch shales, possibly because of the nature of the shales themselves, but undoubtedly better oils can be made than are being produced here to-day once the proper study of retorting methods has been conducted.

Oil production from oil shale is a process of destructive distillation which is not a haphazard affair, but one which must be properly controlled if good results are to be obtained. Obviously there are certain factors influencing oil production from shale, and for any shale the proper thing to do is to determine optimum conditions for producing an oil which will yield the greatest profit.

Factors Influencing Yields.

The Bureau of Mines, in co-operation with the State of Colorado, is investigating certain of these factors in its investigation at Boulder, Col., on Colorado oil shales, with the idea that best conditions, as determined from small-scale experiments, will later be applied commercially in so far as commercial considerations permit. Some of the

factors which can be expected to influence oil yield and quality, and the influence of which should be studied, are set forth below:—

(a) Size of shale particles treated.
(b) Thickness of charge in the retort.
(c) Rate of rise of temperature of the charge.
(d) Maximum temperature to which shale is submitted.
(e) Time of contact with and maximum temperature to which vapours are submitted.
(f) Effect of steam and other vapours and gases.
(g) Pressure under which retorting takes place.

If greatest economic returns are to be obtained from oil-shale operations, the effect of such factors as these should be determined.

Figs. 3 and 4 show, respectively, the retorting and laboratory equipment established at Boulder in connexion with the above-mentioned investigation.

The Shale Oils.

Once the oil is produced, it must be studied to determine its refinability. The high refining loss incurred in Scotch operations has been noted, and efforts should be made, of course, to keep this figure to a minimum in the refining process. New processes of refining and treating may be worked out when the oils produced are thoroughly studied and tried out in commercial operations. The Bureau of Mines, at its Salt Lake City Station, in co-operation with the State of Utah, is studying the oils produced from various shales and by various processes, correlating its work in this regard with the co-operative work in Colorado.

All American shale oils thus far studied by the Bureau are highly unsaturated and contain a considerable amount of nitrogen bases. Some of the unsaturated compounds can probably be allowed to remain in the finished products, but others polymerize and deposit gums and resins which must be removed in refining. The use of steam in Scotch retorts seems to prevent the occurrence of nitrogen bases in the oil to a large extent. It seems that ordinary methods of refining petroleum will have to be modified for shale oil, and such modification can be the result only of thorough study of the oils themselves.

Particular attention is directed to the high loss incurred in refining Scotch shale oil. The refining loss, as has been noted, amounts to about 23 per cent. of the crude treated. Thus, although average Scotch shale yields about 24.5 gallons of crude oil to the ton, only about 20 gallons of this is marketed. As compared with this high loss, the average loss in straight run refining of petroleum in American practice does not exceed 3½ or 4 per cent. If the shale oils thus far examined by the Bureau of Mines are a fair indication of what can be expected from American shales in commercial operations, apparently the loss in refining them by Scotch methods would amount to nearly twice the loss in refining Scotch shale oils. If ordinary petroleum-refining methods are used, probably the loss would be still larger.

Oils are refined for the purpose of making marketable products from them. In refining operations undesirable or offensive substances are removed from the oils in order to make the finished products acceptable to the consumer, but in refining oils which suffer high refining losses,

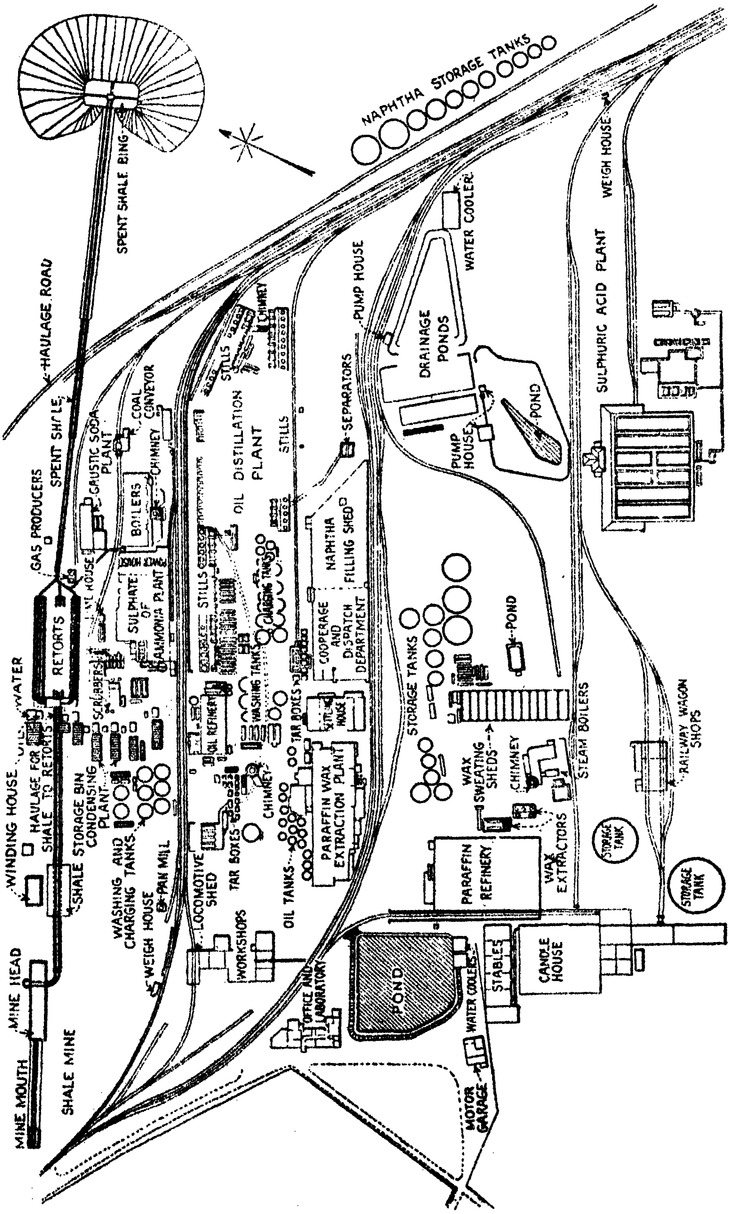


FIG. 2. PLAN OF TYPICAL SCOTCH SHALE WORKS.

such as shale oils, it is probable that not only are objectionable substances removed but a considerable amount of material which might be retained in the finished products to good advantage.

Therefore probably a major problem in shale-oil refining is the reduction of refining losses, either by the development of new or modification of old methods. Such development or modification can come only as the result of technical study of the oils.

A refinery loss is a loss from more than one stand-point. In the first place, there is an actual loss of material, and in the second, treatments in which losses are incurred are more or less expensive. So the refiner not only loses a part of his oil but pays for losing it.

A large part of the refining loss in any event will probably be in the form of acid and alkali tars, and a field of research to utilize these tars is plainly indicated.

FIG. 3. OIL-SHALE RETORTING EQUIPMENT AT BOULDER, COL.

This discussion is intended to call attention to the fact that conditions of retorting and refining should be worked out on a scientific basis if maximum returns are to be expected in oil-shale operations. Each operator should know with scientific accuracy the optimum

conditions for treating his shale and refining his oil. The chemist and chemical engineer will probably have a greater field for research in oil-shale operations than in petroleum production and refining. Particularly the oils need study. It is not possible to predict with accuracy the possible profits a plant can expect, or its costs, until the quality and quantity of products of marketable value it can make are known, as well as the conditions under which they can be made and refined.

When the problem of producing satisfactory products has been solved, there may be a field for research in the study and production of by-products. Discussion of by-products seems premature now, it is true, but later the oil-shale industry may develop an important by-product industry. As a matter of fact, few realize the importance of the present petroleum by-product industry.

When the Scottish oil-shale industry was started, economic conditions were such that the oils produced could be marketed with profit, but these conditions have changed, and since about 1864 the industry has been successful only because of continual improvements that have been made in the technology of shale-oil production and refining. In this regard, Steuart* writes:—

"The Torbanehill mineral† yielded the raw material for about a dozen years, much of it being used in Scotland and some being exported to America and the Continent for distillation.

"In 1862, the supply from this source was being exhausted, and the material became too valuable and expensive for this industry, hence shale was resorted to, but with widely different results. While the Torbanehill mineral yielded about 120 gals. of crude oil per ton, the shales first used furnished 40 to 50 gals., and soon the yield was 30 to 35 gals. The expiry of Young's patent in 1864 led to a rapid expansion of the Scottish oil industry, but ere long it sustained a severe check. The discovery in 1859 of oil wells in Pennsylvania by E. L. Drake was soon followed by the importation of petroleum lamp oil into Britain, the quantity increasing year by year. Owing partly to this competition and partly to the increase in the number of oil works, prices gradually fell. . . . . .

American and Russian Competition.

"At first the Americans exported to Britain only burning oil, but they soon began to introduce supplies of lubricating oil and subsequently of solid paraffin. Then the smaller works (whose retorts had been mostly for the production of burning oil) tended to decrease in number, and the larger ones to increase in size, thus concentrating and cheapening production. Retorts were improved to suit the circumstances, and to produce a purer oil with a larger proportion of heavy products. Mechanical labour-saving arrangements were devised, refining was improved and cheapened, and economies of every kind were introduced. The chemicals used in refining were recovered; and the tars separated by them, the removal of which had involved expense, now became a source of profit as fuel. The supply of Peruvian guano began to fail,

* Steuart, D. R., "The Oil Shales of the Lothians"—Part III. "The Chemistry of the Oil Shales." "Memoirs of the Geological Survey," Scotland, pp. 137-138.

† A very rich oil shale.

hence the price of sulphate of ammonia rose to £22 (1880) and even to £24 per ton; but as the importation of nitrate of soda increased greatly, it fell below £8 per ton about 1890, when burning oil sold at less than 6d. per gal. These conditions led to further concentration. Retorts especially designed for the manufacture of sulphate of ammonia were universally adopted, and improvements were introduced to secure greater economy of working. With the older type of retorts a shale had to yield about 30 gals. of crude oil per ton in order to be profitable: but with the new retorts and the increased yield of ammonia and fuel gas a shale furnishing 20 gals. is remunerative. Not more than 16 lb. of sulphate of ammonia per ton was formerly obtained as a maximum, now 35 to 70 lbs. is got, according to the quality of the shale. By these methods the quality of shale that can be worked with profit has been increased and the life of the Scottish industry has been lengthened.

"Since 1873 the Russian petroleum industry has developed rapidly, and in recent years competition from this source has become very severe. Russian crude oil, however, produces no solid paraffin; and America shows signs of not being able to respond as easily as formerly to the increased demands of the world for petroleum, any increase in American output being fuel oil. In 1905, however, it succeeded by great effort in making up for the Russian deficiency caused by troubles at Baku. In 1909 and 1910 there was a definite decrease in the export of burning oil from America to Britain. Sulphate of ammonia is being produced in greater quantities from iron works, coke ovens, Mond gas producers, &c.; but the demand also increases. New competitors are always arising; recently, for instance, Galicia with solid paraffin, Rumania with burning oil, and the Dutch East Indies with motor spirit. But notwithstanding this prolonged and fierce struggle for existence, the Scottish industry still survives. The Scottish companies vie with one another in their efforts to improve and cheapen the processes, and show signs of mutual helpfulness and co-operation. In the early days of the industry operations were carried on in a simple but expensive fashion. Sometimes the shale was carted miles to the retorts, and the crude oil carted miles to the refinery, and breaking shale, pumping oil, &c., were done by manual labour. But through all these years evolution has been at work in developing a high state of organization, resulting in economy and efficiency. The most of the existing works have adopted electricity for lighting and for the conveyance of power for all purposes.

"In 1894 there were thirteen oil companies in Scotland; now there are only seven (three of which produce crude oil only), but the output has not been reduced."*

New and Improved Practice Being Developed.

Thus there is seen the continual application of new and improved practice in the Scotch industry, a practical seeking after better methods, perhaps not by means of strictly scientific research, but nevertheless by research, which, conducted in a practical manner and with a definite object in view, has kept the industry alive. It may be noted that the

* The largest of these consolidated into one company, Scottish Oils Ltd., in 1919.—Author.

only companies in Scotland which have survived during the long years of competition have been those which could afford to experiment and had the capital at hand to conduct operations in a large way under the supervision of trained technicians and executives. Once a market had been established for certain products, efforts have continually been made to increase the yield of those products and lower production cost.

The oil-shale industry in this country will afford a field for the mining and mechanical engineer, as well as for the chemist and chemical engineer. Mining the shale is bound to furnish a very important item in the total cost of producing refined shale-oil products. In Scotland the cost of mining the shale is well over 50 per cent. of the total cost of making refined shale oils. The mining of shale oil in this country should offer the mining engineer an opportunity to devise new methods of drilling, breaking down, hoisting, conveying, crushing and the like, and permit the reduction in total costs by supplementing high priced mine labour with mechanical devices.

Retort Construction.

Retort construction is a problem for the mechanical and chemical engineer. The Scotch retort, when carefully examined, is found to be admirably suited for its task. A notable feature in its design is the manner in which provision is made for the expansion and contraction of each retort in a unit, independently of any of the others. The average life of the best types of Scotch retort is well over twelve years; the

FIG. 4. OIL-SHALE LABORATORY AT BOULDER, COL.

value of this figure can be appreciated when it is learned that the life of the first retorts used was only one and a half to two years. The mechanical engineer may be asked to adapt the Scotch retort to American shales, and the writer believes it to be capable of considerable modification for certain definite purposes. Its freedom from complicated mechanical devices, long life and satisfactory performance for so many

years in Scotland make it difficult to disregard its use in this country without complete trial. A shale retort must be rugged enough to operate continuously for long periods at comparatively high temperatures handling an abrasive material. As has been the case in coal by-products plants, the engineer may be able to substitute ordinary firebrick with other refractories, such as silica brick, and there may be a new field for the use of alloys and metals with protective coatings designed to resist oxidation at high temperatures. In the refining of the oils it is expected that while much of the ordinary petroleum-refining equipment can be used, probably much of it may have to be modified, and there are distinctly seen the possibilities of new refining processes, equipment for which the chemical and mechanical engineer will be called upon to supply.

SUCCESS AHEAD.

The future of an oil-shale industry is practically assured in this country by the increasing consumption here of petroleum and its products over domestic production of petroleum. Indications are that in the comparatively near future the United States must import the bulk of its petroleum or find a substitute or new source of hydrocarbon oils. While possibilities in the use of such substitutes as alcohol and coal-tar products cannot be disregarded, the writer sees in oil shale the natural and logical source of oils to make up in large part the coming deficit between domestic consumption and production of natural petroleum. It seems certain that motor fuels, burning oils, fuel oils and paraffin wax can be made from shale oil, but there is considerable doubt as to the possibility of producing more than moderately viscous lubricating oils from them. Between the knowledge that certain oils can be produced and their actual commercial production is a large gap which must be filled by properly directed research and investigational work. There are reasons to believe that a company, well organized, with plenty of capital and well equipped with business and technical men, if situated favorably, would have a reasonable chance of establishing successful commercial shale-oil production, if not at the present time, at least in the near future. The necessity for technical investigations and control, however, cannot be too strongly emphasized, because the oil-shale industry, in its final analysis, is nothing but a low-grade raw material chemical manufacturing enterprise, which, when economic conditions are right, depends on capital and business and technical ability for success.

Blackboy and its Uses.

By C. E. LANE POOLE.

THE Western Australian "Blackboy" (*Xanthorrhœa Preissii*) belongs to the same species as the "grass-tree" of the eastern portions of Australia. It is a familiar feature in the forest areas of Western Australia, and it is to be found in more or less abundance throughout the agricultural areas. The stems of the common Western Australian species are ordinarily from 7 to 8 feet high, but often run up to 15 feet in height, and are usually branched. It may interest many to know that the "Blackboy" belongs to the lily family, a botanical paradox more readily appreciated by the scientist than by the layman. It is constructed of a centre core, and a very fibrous, somewhat spongy, material, sometimes hard enough to be termed wood, which contains a large amount of easily fermentable, sugary substance, surrounded by a thick coating of "husk," formed of the persistent bases of the old leaves lying very closely packed together, and more or less cemented by resin into a hard, coherent mass. When fire spreads through an area in which "Blackboy" is found, it readily attacks this hard outside layer, burning and scorching it, and this accounts for the fact that the barrel of the tree is always black, with all the appearance of having suffered from recent fire. When the "husk" is broken up and beaten, the brittle resin is easily reduced to a fine powder, which may be with little difficulty separated from the fibrous skeleton on which it is built up. When heated, this powder forms into lumps, and becomes a substance known as "Blackboy gum." In areas covered by "Blackboy," this gum is found in lumps in the ground, the gum having probably been separated from the tree by fire, and coagulated where it reached the surface of the ground. As the "Blackboy" covers very large tracts in Western Australia, its trunks can be obtained in enormous quantities, and the gum or resin might well form the basis of a large industry. From experiments made by competent analysts, something of the potentialities contained in "Blackboy" have been ascertained. Among the products obtained have been glucose, treacle, scents, alcohol, and certain tar products, and from these latter, again, two dyes have been obtained. Picric acid, so much used in explosives, is also yielded by the tree, the gum, on treatment, giving up to 50 per cent. of its weight in the form of picric acid. The Munitions Department in England, during the war, made experiments with "Blackboy" gum as a producer of picric acid, and was highly satisfied with the result. There would seem to be a great future for "Blackboy" by-products. The subject, although well investigated by competent authorities, has not yet been exhausted. In the early days of Western Australia, the settlers obtained a form of alcohol from "Blackboy," which they used as a stimulant. This aspect of the question has been further treated by Mr. E. A. Mann, Analyst to the Government of

Western Australia. The following table gives the results obtained by Mr. Mann:—

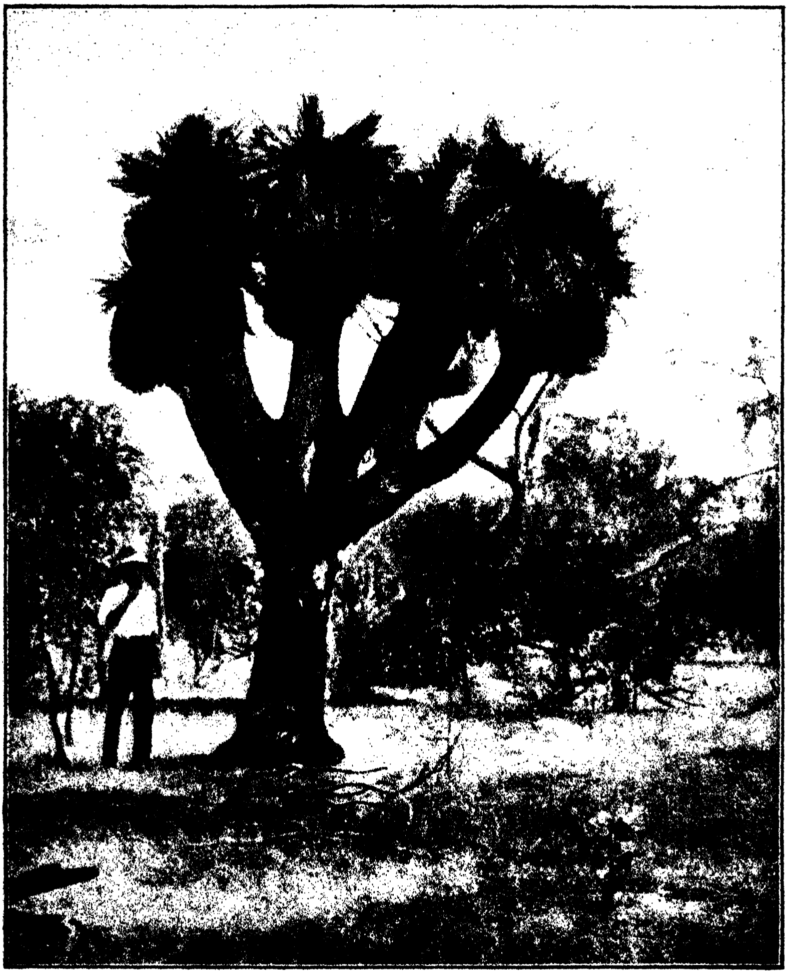
Month.	Weight of sliced core.	Proof gallons spirit per bushel (60 lbs.)	Equivalent sugar per 100 core.	Per cent. sugar by analysis.
September ..	350 grms.	1.24	20.6	26.1
February ..	6 lb.	0.8	13.2	not determined.
June ..	2½ cwt.	0.5	10.0	10.5

KINGIA AUSTRALIS (Western Australia).

BLACKBOY AND ITS USES.

Western Australia is in a position to supply annually thousands of tons of clean "Blackboy" gum at a price which should meet the views of manufacturing chemists whose business includes the many valuable distillates that can be obtained from the gum. Particularly in the matter of dye stuffs the capabilities of the resin should form the subject of a thorough investigation.

A number of investigators have turned their attention to "Blackboy," pursuing inquiries into its chemical constituents and their commercial value and utility. The outside sheathing of "Blackboy" is rich in many directions, yielding, amongst other matters, drying oils and turpentine substitutes suitable for the manufacture of paints and varnishes,



BLACKBOY (Xanthorrhoea Preissii) Western Australia.

and also for other purposes. The yields vary according to whether the material is treated dry or not. The following are given by one experimenter as the extreme limits per ton of material used:—

35-45 gallons of water.

25-30 gallons of liquor, containing 12-15% of acetic acid.

4-5% of methl alcohol and 2-3% of light spirit.

25 gallons of crude oil, containing 10% light oil, 10% medium oil, 15% phenols and acids, 60% pitch, 5% loss (approx.).

8 cwt. of coke residue of high calorific value and gas (5,000 cubic feet).

A coke residue of very good quality remains. This can be made into briquettes with any suitable matrix. It has been stated that the gross value of the products derivable from the low-temperature retorting of "Blackboy" is greater than that from any other naturally occurring organic material in Australia.

Scientific and Technical Societies.

ROYAL SOCIETY OF VICTORIA.

At the November meeting the following paper was read:—

A Description of the Bracebridge Wilson Collection of Victorian Chitons, with Description of a New Species from New Zealand. By Edwin Ashby, F.L.S., M.B.O.U.

This collection was made by the late Mr. J. Bracebridge Wilson, working in connexion with the Port Phillip Exploration Committee of the Royal Society, and was dealt with in a very able manner by Mr. E. R. Sykes, B.A., F.Z.S., in the Proceedings of the Malakalogical Society in 1896.

In view of more recent investigations by a number of earnest workers, it has been found necessary to alter some of Sykes' identifications. Considering the comparatively small number of specimens, the collection is a most remarkable one, and contains an extraordinary percentage of rarities. In addition to the five species described by Sykes as new, the author notes four other species then undescribed. One of these, *Callochiton rufus*, Ashby, has hitherto been only known by a single type specimen dredged in South Australia. A new species of *Lepidopleurus*, from New Zealand, is also described.

Dr. J. M. Baldwin delivered a lecture on Application of Genetics to Plant Breeding.

During the past twenty years activity has been displayed in plant breeding throughout the world. This activity is largely due to the re-discovery of Mendel's work by De Vries, Correns, and Tschernak, the epoch making work of De Vries on the Mutation Theory, and the stimulus given through the establishment of schools of genetics throughout the world. The problems of genetics are those which grow out of a study of the resemblances and differences in individuals related by descent. There are four general lines of attacking the problems—(*a*) the method of observation used by Darwin in marshalling evidence in favour of the evolution theory; (*b*) biometrical methods, employed with such success by Pearson; (*c*) cytological methods, which are primarily concerned with a study of cell mechanism; (*d*) experimental breeding, which involves the raising of pedigreed cultures of plants. From the last method have come many stimulating ideas of heredity and variation, including the Mendelian theory of heredity, the pure line theory of Johannsen, and the mutation theory of De Vries. One important result of this method of analysis is to demonstrate that the germinal material is made up of definite factors or units which stand in close relationship to the particular characters of the soma, and to demonstrate how these elements are transmitted from generation to generation. The pure line theory and the mutation theory stand in close relationship to the Mendelian theory, because they may be interpreted in terms of the elements which constitute the germinal substance. Johannsen showed that the fluctuations produced by differences in moisture, sunlight, and fertilizer received by the different individual plants, *i.e.*, fluctuations induced by the plants' environment, were not inherited. They behaved exactly as the acquired characters of an animal which Weismann showed were not inherited. Variations among individuals of like germinal constitution is a response to external or internal conditions which are not reflected in the germinal substance, and such variations are of no consequence for the establishment of new hereditary characters. The mutation theory established the occurrence of occasional definite discontinuous changes in the germinal substance, in consequence of which new characters are added to the race. Mendelism has given us a plan of heredity, but the more intimate and fundamental knowledge of the material which is employed in the elaboration of the plan remain the task of cytological research. Genetics may be applied on the scientific side to formulate doctrines of evolution, and on the practical side to the production of improved races of plants. New and improved varieties may be produced by selection or hybridization. While great improvement had been wrought in plants by selection, the main *rôle* of selection was to isolate the heritable variations which are so much rarer than the discontinuous fluctuations

produced in the plant by its environment. When the desired heritable variant is isolated, selection can do nothing more until nature produces another heritable variation. In other words, selection cannot create anything new. It merely isolates and preserves any heritable variations produced by nature. These principles were illustrated by the results obtained in the breeding of sugar beets and the Illinois corn-breeding experiments. Hybridization offers unlimited opportunity for the production of new types of plants. The Mendelian conception of the plant being composed of unit characters based on specific factors transmitted in accordance with a definite scheme of inheritance is of great service to the plant breeder, because his final objective is the production of a type which will combine in one variety the greatest number of desirable properties. The mode of inheritance of many unit characters has been worked out, but the inheritance of qualities of economic importance, *e.g.*, yielding capacity, disease resistance, milling quality, drought resistance, still remain unsolved. As the applications of Mendel's discovery are extended, it is bound to have a great influence on the breeding of plants, for it will ultimately provide the breeder with definite knowledge as to the manner in which every unit character of practical significance is inherited, and the manner in which the characters may be associated and combined for the production of improved types of plants.

Mr. F. Chapman, A.L.S., exhibited two remarkably well-preserved plant fossils in the volcanic tuff of Mount Gambier, from the National Museum collection. One is the frond of the common bracken (*Pteridium aquilinum*), the other a leaf of the silver banksia (*B. marginata*) still living in the district. It was pointed out that the volcanic tuff in which they are enclosed represents the last stages of volcanic activity, and that the tuff cones, together with the basal lava flows, were partially swallowed up by subsidence similar to that giving rise to the caldera of Tower Hill, and since filled up by the water forming the Valley and Blue Lakes. The tuff formed a bed 200 feet thick in one part, and the volcanic dust drifted 7 miles to the north-east, covering much growing vegetation. The occurrence of the ubiquitous bracken shows that it was established long before settlement by man.

At the December meeting the following papers were read:—

1. Researches into the Serological Diagnosis of Contagious Pleuro-Pneumonia of Cattle. By G. G. Heslop, M.V.Sc., D.V.H. (Walter and Eliza Hall Fellow). (Communicated by Professor H. A. Woodruff.)

2. New or Little-known Victorian Fossils in the National Museum. Part XXV.: Some Silurian Corals. By F. Chapman, A.L.S.

The author describes six new corals, and gives detailed observations on two others. The corals all belong to the Yeringian stage of the silurian.

3. Contributions to the Flora of Australia. No. 29. By A. J. Ewart, D.Sc., Ph.D.

This forms No. 29 of the author's "Contributions," which have been published from time to time in the proceedings of the Society. *Beyeria virgata* is a new species collected on the Elder Exploring Expedition from the sand hills near Lefroy, Western Australia, and was placed for a long time under *B. brevifolia*, from which it is, however, quite distinct.

4. The Estimation of Acidity. By Dr. J. M. Lewis. (Communicated by Professor W. A. Osborne.)

The paper deals with various methods which are in practice available for the determination of the hydrogen ion concentration of solutions, *i.e.*, (1) the use of a "ladder" of indicators after the manner of Salm and Sorensen, with the improvements in method which have more recently been introduced; (2) the hydrolysis of esters; and, lastly, and principally, with the electrometric method.

The writer deals at length with the theory of "contact potential," and shows how the development of the method is due to the work of such men as Van't Hoff, Nernst, Sörensen, and Wilsmore, to mention some prominent names only.

The use and construction of the calomel electrode of Ostwald is explained, and the Poggendorff compensation method of measuring the small e.m.f. developed by the system when arranged for an estimation of hydrogen ion concentration is

fully dealt with. The calculation of the actual hydrogen ion concentration from the found e.m.f. by means of Nernst's equation is demonstrated, likewise that of theP_H or negative logarithm of the concentration, *i.e.*, Sörensen's negative hydrogen ion exponent.

Another section of the paper deals with the various forms of hydrogen electrode employed in this work, and special mention is made of the improvements introduced by Walpole. Walpole's technique was further modified by Barendrecht, and the form of apparatus devised by the latter, and improved by the writer, is fully described. The author's improvement consists principally of a ratchet and pinion which is attached to the plunger which regulates the height of the liquid in the electrode, and by its means a very accurate adjustment may be made.

The author also introduces an "inert" electrode into the electrode tube which greatly facilitates the coating of the wire with "platinum black." Some electrode tubes are shown which contain two platinum electrodes in addition to the "inert" electrode before mentioned. These "twin electrodes" may be tested against one another, and may, at times, be of service in avoiding errors associated with faulty platinizing of the electrodes. The technique of electrode platinizing is fully described, and the writer illustrates a useful device which he has developed for the speedy coating of the wire and its subsequent cleansing during the electrolysis of dilute sulphuric acid.

The writer emphasizes the importance the estimation of hydrogen ion concentration has acquired, not only in biochemical investigations, but also in bacteriology and in the arts, and the paper concludes with a useful bibliography of the subject.

ROYAL SOCIETY OF QUEENSLAND.

At the November meeting the following papers were read:—

"The Peach-leaf Poison Bush." By F. B. Smith, B.Sc., F.I.C., and C. T. White, F.L.S.

"Contributions to the Orchidaceous Flora of Queensland." By Dr. R. S. Rogers, M.A., M.D., and C. T. White, F.L.S.

In their paper on the "Peach-leaf Poison Bush" (*Trema aspera*): Its Occasional Toxicity, Messrs. Smith and White pointed out that concerning many plants recorded as injurious or poisonous to stock in Australia there is much diversity of opinion among stock-holders. As a case in point may be cited *Trema aspera*, common in the eastern States and variously known as "Peach-leaf Poison Bush," "Wild Peach," "Peach Poison," &c. This plant is regarded by some as a good and safe forage plant, but by others as one of our worst poisonous plants.

There are numerous references to *Trema* as a dangerous fodder in the writings of Australian botanists. The bark is very fibrous, and it has been held that the harmful effects attributed to the plant are due to its tough and indigestible nature when ingested by stock in the absence of softer and more palatable feed, especially in view of the fact that the plant belongs to a family of plants—the Ulmaceæ—the members of which, as a general rule, are quite wholesome and free from poisonous properties.

Recent observations of the writers would, however, definitely show that the plant is at times capable of producing mortality in stock, and is worthy of the reputation imputed in the popular naming.

The closely allied *Trema timorensis*, Blume. (Syn. T. virgata, *Blume*. Sponia virgata, *Planch.*) has already been recorded as prussic-acid yielding. In a continuation of a survey of the Queensland Flora, made by us for the occurrence of prussic acid (cyanogenetic glucosides), the occasional presence of faint traces of this poison in *Trema aspera* was noted. Latterly (March, 1920), in connexion with an inquiry into cases of fatality among stock in the Beaudesert district, Southern Queensland, portions of *Trema aspera* were gathered, which evidenced the presence of an amygdalin-like glucoside both in the "bitter almond" odour when the leaves were rubbed between the hands and also by pronounced positive reactions in the usual test made with "Guignard's" soda picrate paper.

The transitory appearance of hydrocyanic acid has been noted by Greshoff in Hydrangea and certain ferns, and its periodicity in economic plants of the Sorghum group is well known, and similar occurrence of the poison in *Trema*

aspera in sufficient amount in certain situations, or at certain seasons, is in accord with the sporadic and sudden fatalities occasionally observed among stock grazing where the plant is abundant.

ROYAL SOCIETY OF NEW SOUTH WALES

At the December meeting the following papers were read:—

1. "The Stethoscope, with a reference to a Function of the Auricle." By J. A. Pollock, D.Sc., F.R.S.

Various forms of stethoscope are considered, and as a general result of the discussion it appears that the acoustic determination of surface vibrations has, in the last resort, when the disturbances are very small, a definite dynamical aspect, the delection in all the instances described depending on the movements of the surface relative to a "steady mass" elastically connected with it. In delecting small movements with the old-fashioned stethoscope, or after the manner of the tracker, the mechanism is supplied by the head and ear, the auricle having the very definite function of acting as the elastic connexion between the mass and the surface. In other cases where the air disturbances are led by tubes directly into the ear passages the mechanical action is recognisable associated with the instruments.

The Chemistry of the Essential Oils obtained from two teatrees found frequenting the beds of Creeks and Rivers in Southern New South Wales, known as *Leptospermum odoratum* and *Leptospermum grandiflorum*. By A. R. Penfold, F.C.S.

The principal constituents of the former are Eudesmene and Aromadendrene (Sesquiterpenes), Eudesmol (Sesquiterpene Alcohol), Alpha and Beta Pinene, with smaller amounts of a rose odour Alcohol, Esters, and Phenols.

This is the first time that Eudesmene has been found occurring in nature.

Leptospermum grandiflorum consists principally of the same two Sesquiterpenes with an unidentified Sesquiterpene alcohol.

The constants of the two oils are:—

	Leptospermum Odoratum.	Leptospermum Grandiflorum.
Percentage yield of Oil from leaves ..	0·75%	0·61%
Specific gravity at 15°C.	0·9280	0·9324
Optical Rotation	−19·02	−2·42
Refractive Index at 20°C.	1·4990	1·5048
Ester No.	7·2	7·2
Ester after Acetylation	91·93	41·

Eucalyptus Oil Glands. By M. B. Welch, B.Sc. One of the main characteristics of the eucalypts is the presence of oil in the leaves. The extraction of this oil for therapeutics, perfumery, and mining purposes is an important Australian industry. The oil was formerly considered to be present as a single globule contained in a small cavity, but it would now appear that it is rather in the form of an emulsion. These cavities usually, though not always, approach the surface. Oil occurs also in the stems, buds, fruit, and, in rare species, in the barks, and its presence in these various organs is considered in this paper. The glands are often more or less devoid of contents, and in the different species show decided variation in arrangement and number. Their origin is evidently due to the separation of certain cell tissues, and their subsequent disintegration.

COMMONWEALTH OF AUSTRALIA.

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